AGRICULTURAL ENGINEERING

Published by the American Society of Agricultural Engineers

Headquarters of the Society: Saint Joseph, Michigan

Ralph U. Blasingame, *President* — Raymond Olney, *Secretary-Treasurer*

Volume 17 — AUGUST, 1936 — Number 8

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Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the headquarters of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cent a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . .

AGRICULTURAL ENGINEERING

VOL 17, NO 8 EDITORIALS AUGUST 1936

Illinois and Its Amazing Century

DECISION by the American Society of Agricultural Engineers, at the annual meeting concluded in June, to hold its annual meeting in 1937 on the campus of the University of Illinois comes with a peculiar fitness which apparently played no part in the decision. By a rough sort of alternation among the major geographical regions, superimposed on a succession of suitable places, it was natural that Illinois should have its turn. This turn came with no regard to the coincidence which it constitutes.

Many meetings, annual and otherwise, have been held at Chicago. But Chicago is a metropolis, a center of transportation, which belongs to the whole midwest and, agriculturally speaking, to the nation. The twin cities of Champaign and Urbana, with the university and the experiment stations there, stand for education and research in Illinois as a state. It comes with historical propriety that Illinois is to be host to the agricultural engineering profession in the hundredth anniversary year of the steel plow.

Just as seven cities are said to have claimed to be the birthplace of the poet Homer, so have elements of uncertainty crept into the story of the steel plow. Pioneers ever have been more concerned with realities than with records, and the mechanism of memory makes it excusable, if not inevitable, that their later recollections are more accurate as to incident than as to its exact timing. Nevertheless the composite of documentary evidence with other historical elements points to 1837, perhaps not as the year of discovery, but as the beginning of the development that solved the scouring problem for the prairie region.

Be that as it may, the steel plow marked an advance in the realm of materials for agricultural engineering. Progress as to design preceded and followed in a rather steady sequence. The introduction of the new material was revolutionary and epochal. In the zone of its adaptation, and in the essence of its composition and character, plow steel has held undisputed sway for the whole hundred years. Variations in carbon content, heat-treatment, and of expedients to achieve a tough core are but refinements which have not shaken the basic relation between material of soil-working surface and the character of the soil itself.

A hundred years is as a day in the long history of agriculture. But in a century wherein plowing power progressed from ox to tractor; harvest tools from cradle and flail to binder, thresher, and combine; haying equipment from scythe and pitchfork to the pick-up baler and cut-hay container; in a century which witnessed the rise of rubber, wood-pulp paper, petroleum, and synthetic dyestuffs—in such a century the permanence of plow steel is no less amazing than its adoption was significant. We well may do homage to Illinois as the cradle of the steel plow.

What of the next century? Already more emphasis has begun to focus on the materials of agricultural engineering. Plows and other tillage members have drawn attention with the mysterious force of a magnet—and with little more effect, apparently, than the fringe of iron filings on the steel of a magnet. Yet he would lack the vision of the engineer who dares declare that metals for tillage have reached finality. Let Illinois celebrate her century while she may.

Picking Posies with Power

VIEWED by itself, the development of pyrethrum harvesting devices, reported in AGRICULTURAL ENGINEERING for July, by the USDA Bureau of Agricultural Engineering, may seem a minor matter. As an item in a far-flung program it becomes a symbol of significance.

Even when imported, in order to take advantage of the so-called pauper labor of foreign lands, pyrethrum produced by hand methods is far too costly to take its logical place as a non-poisonous insecticide. In terms of narrow nationalism such imports, small as they are, are objectionable. In terms of a broader humanity it is a doubtful benefit to any people, anywhere, to perpetuate primitive, low-production methods that keep workers in a state of peasantry or peonage.

Whether or not pyrethrum is the particular product to play a major part, we are launched on a program for better pest control methods. Between increasingly intensive spray schedules and steadily more stringent lead and arsenic tolerances we must look more and more to what may be called differential poisons, and to non-poisonous methods of control. The ASAE technical committee on pest control was formed none too soon. All that it can do toward the more efficient application of traditional insecticides and fungicides, the abundant and economic production of non-toxic substitutes, and their supplementation with electrical, thermal, and mechanical methods will not be too much in mankind's perpetual battle with the bug.

Machine methods in the production of pyrethrum are a symbol, too, of the agricultural engineer's part in the impending growth of a greater "factory stomach" for the products of agriculture as proclaimed by Past-President Livingston of the ASAE, promoted by the chemurgists, and practiced by Henry Ford—to mention only a few names from among the many. Obviously we must broaden our vision. No longer can we be content to polish up the production methods for wheat, cotton, and corn. We must devise machines to make crops of dahlias, artichokes, pine trees, just as we acclimated ourselves to soybeans and sweet clover. We must think not only of new markets for our crops but new crops for our soils and our machines.

Nor should we pass the pyrethrum without noting its implied challenge of preliminary processing. The more promising method of machine harvest calls for "drying in thin layers under shelter." That is not the method of economical mass production. The next step would seem to be artificial dehydration—another activity in which agricultural engineering has led, even though it has lately been in eclipse. However much we may err in particulars, however trivial may be pyrethrum, we can hardly be wrong in the general conviction that agriculture and its own branch of engineering are at the eve of change and expansion.

"Bricks Without Brains"

UNDER this devastating title Grosvenor Atterbury contributes the leading article to the April 1936 number of *Architecture*. His subtitle, "A Challenge to Science, and the Factory-Made House," suggests both his theme and our reasons for referring to it here. Here is how his article starts:

"You can buy a first-rate automobile today for around twenty cents a pound—the price of ordinary lard. Twenty-five years ago you would have paid just about ten times the price for a car incomparably inferior in every way. On the other hand, during that same period of time the price of a small house has about doubled—and it is probably not as well built today as it was twenty-five years ago."

How Mr. Atterbury explains this, what he proposes to do about it, and the tangible evidence that he adduces in support of his thesis are too worthy of full reading to be cheapened by attempted summary here. We merely point out that the small homes which are his subject matter are close kin of the farmhouse. What is perhaps even more to the point, the principle of factory-made buildings is as much or more applicable to other farmstead structures as to the dwelling. Sundry supporting facts might be mentioned, but they come to this: Farm structures are the logical place for manufactured buildings to make their start, and they represent the largest single field in which a huge potential market might well be activated by the economies which modern manufacture promises to bring to the building art.

But before industry can be expected to plunge into the mass manufacture of granaries and hog houses, there must be some agreement as to what a granary or a hog house should be like. Nor is mere agreement enough; it should be founded on a knowledge of the job requirement. Coordinated movements like that of the Midwest Farm Building Plan Service are a substantial step in the right direction. Yet they are somewhat empirical developments. We still have need for fundamental studies, such as those proposed in the ASAE Structures Division, into the needs, purposes, and economics of animal shelters. When we know with some certainty what a cow barn should do and what it is worth to do it, industry will have more assurance in tooling up for barn manufacture.

Agricultural Engineers in Upstream Engineering

AGRICULTURAL engineers necessarily watch with interest the growing recognition of the fact that water runs down hill; that floods downstream are accumulations of raindrops and snowflakes that fall on farms and forests; that engineering control of this water may well begin at the point of precipitation.

Organization of a conference on upstream engineering at the instance of President Roosevelt, to mobilize forces for engineering mastery of streams at their headwaters, is significant recognition for engineering, and should prove fruitful of much public good.

That an unobtrusive body of agricultural engineers have a head start of twenty to thirty years in working on certain phases of the now popular problem of upstream engineering, is significant. It should enable them to render an important contribution to the proposed consolidation of information.

That the humanitarian inspiration for the conference may not have been fully aware of the valuable foundation for upstream engineering which agricultural engineers have established; that it may not name them specifically for major participation in the conference, is not too significant. It does not mean that agricultural engineers are or can be left out of any well-rounded conference on the subject. It means that they must make known their place in the field.

An open invitation for comments, suggestions and attendance has been extended. The conference is only a start. It will accomplish its purpose if it initiates an effective orientation and organization for years of follow-up work on upstream engineering problems. Agricultural engineers will do their part by making known the facts they have learned, the conclusions justified by these facts, the points on which they need support for further research, the points on which they may need collaborative help from other specialists, and the points on which they believe they can, with support, contribute materially to the collaboration.

The agricultural engineering position in upstream engineering is sound, solid and time-tested. In its seventeen years AGRICULTURAL ENGINEERING has published 140 articles on various phases of the subject, by 90 authors, over half of whom are agricultural engineers active in the ASAE, and in a position to bring these articles fully up to date. Nor does this include all the articles which might have some bearing on the subject; nor the papers published in Transactions of the Society, but not in AGRICULTURAL ENGINEERING; nor all of the agricultural engineers active in this field. It is merely suggestive of the wealth of information, training, and experience which agricultural engineers have to contribute to the conference and subsequent work.

In upstream engineering agricultural engineers stand between civil engineers and agricultural scientists, presenting with them a united front on water-control problems. Dealing with the characteristics, forms, and proportions of water as it is found on individual farms and groups of farms, agricultural engineers have been doing effective work for years in controlling and using water to the order of the agricultural scientists.

In this they neither conflict with nor duplicate the work of civil, military and other engineers in major water-control works such as dams, diversions and levees, city water supplies, sanitation, power developments, shipping, and irrigation storage. They supplement it. They are further up stream.

Agricultural engineering, as a definite branch of the engineering profession, is too well established to be seriously questioned in its field. It fills too great a need to be ignored. It requires too much special training and experience to be absorbed by other branches. Its future in its field is limited only by the foresight, activity and public spirit of its members.

Agricultural engineers may well, therefore, respond to the invitation to comment on, suggest to, and attend the Upstream Engineering Conference to be held in Washington, September 22 and 23, with information as to what they have done and what they believe they can do in upstream engineering; and with assurance of the inherent integrity of their position as agricultural engineers in upstream engineering.

Planning the Use of Our Irrigation Resources

By Frank Adams

THE TITLE of this paper limits it to a discussion of planning the use of our irrigation resources, which are usually considered to be our irrigable lands and the water needed by them for agricultural production. But in many instances the best use of our irrigation resources as thus defined can not be accomplished without also taking into account other natural resources, and other uses of land and water than for farming. We cannot properly overlook the interrelationships between irrigation farming and the best use of our western grazing lands, or the development and best use of our hydroelectric resources. We must recognize that cities, industries, and irrigated lands are mutually interdependent; that the extent to which the products of our irrigated lands compete with the products of the Middle West and the East may materially affect the success of our irrigation enterprises; that increased production in the Mississippi Valley and along the Atlantic seaboard through extension of supplemental irrigation there may further challenge our markets. In the arid region we have constantly to bear in mind that, in a very large and in many cases a controlling way, the manner, place, and measure in which we conserve and use our irrigation resources determine what kind of a country we are to have, where our people are to live, and how well or how ill they are to prosper.

IRRIGATION PLANNING NOT A NEW CONCEPT

During the last few years this country has become planning-minded. This planning-mindedness is a definite national asset, and if the planning is kept within reasonable bounds, and not undertaken except with a clear objective and then along practical lines, it is worthy of our heartiest support. But as to the use of our irrigation resources, planning is not a new concept. Western people associated with irrigation have been planning for a good many years, although some of our plans have merely been dreams, and although the sum-total of our planning has been inadequate.

Major Powell's monograph on the lands of the arid region, written in 1878, was a venture in planning the use of our irrigation resources of a fundamental character. So was the work of Dr. Elwood Mead when, as first territorial and first state engineer of Wyoming nearly fifty years ago, he enumerated the principles of administration of our public waters which have been the model for most of the other western states and for a number of other countries, and outlined what he considered to be needed in the matter of planning. Let me quote briefly from his second annual report as territorial engineer of Wyoming, written in 1889:

> There is every reason to believe that we are now at a turning point in the history of this interest (in irrigation) not only in this territory, but throughout the arid belt, in which the unaided and, in many cases, misdirected efforts of individuals are to give way to works constructed according to systematic plans having for their object the economical distribution of water and the reclamation of the largest areas of land.
>
> We are fast coming to realize that agricultural values inhere in the water rather than in the land which it reclaims, and with this knowledge is the conviction that more efficient supervision is required in its disposal and utilization. . . . . . .
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> Since the ultimate extension of the cultivated area will depend on the water supply, measures should be taken to secure its proper distribution and economical use, and, since all of the land cannot be reclaimed, care should be taken in the building of ditches that they be so located as to water only the best.

STATE ACTIVITIES IN WATER PLANNING

Use of irrigation resources in the West naturally had to proceed, in the first instance, on the basis of demands and opportunities for local development, with very little thought by land and water users as to the future. Individuals and groups moved in to settle or make their stake under the pioneer conditions prevailing. Water for irrigation was necessary if they were to farm the land. They acquired rights to use this water under the local customs or laws and built their ditches, concerned only with their own affairs and their own interests. There was no governmental restraint. On the contrary, this kind of activity was promoted and welcomed. Naturally what was done was haphazard; it could not have been otherwise. Yet in spite of this there was planning by the pioneer leaders concerned with such matters, as the early reports of Major Powell and Dr. Mead indicate. Even earlier than these, in 1874, during the administration of President Grant, the Alexander-Mendell-Davidson federal report on irrigation of the Sacramento, Tulare, and San Joaquin valleys of California proposed a comprehensive plan for the irrigation of the Central Valley of California which was as broad in its concept as the Central Valley project plan that the state and the federal government have developed during the past decade, although of course lacking the detail or the completeness of the latter. Fifteen years ago the Utah Water Storage Commission was created and proceeded to the development of a plan for the ultimate best use of that state's water resources. Cooperating with the Bureau of Reclamation of the U. S. Department of the Interior, they have centered chiefly on the Salt Lake Basin area, and very substantial progress has been made, not only on a coordinated plan, but on the construction program. Under a special appropriation of a quarter of a million dollars by Congress, the Bureau of Reclamation is now engaged in a comprehensive study of the best use of the Colorado throughout its great drainage basin, supplementing their studies started in 1919 which led to the development of the Boulder Canyon project.

The Bureau is also engaged in other similar studies covering stream systems or areas, notably in southwest Idaho and the Black Hills area of South Dakota. Other examples of early stream or basin planning in the arid and semi-arid regions might be cited.

Every state from the Dakotas, Nebraska, Kansas, and Texas west maintains a state department of engineering or equivalent department whose function is in large measure to control the use of its water resources. While lacking either authority or means to guide the use of these resources, except in a general way and through educational leadership, or through authority to refuse applications for permits to appropriate water when the proposed use is deemed adverse to the public interest, these departments nevertheless exert a substantial influence on the nature and plan of development. The usual procedure, if construction of works is in mind, is for the state, or those interested in a particular development, to seek the assistance of the Bureau of Reclamation in the engineering studies and planning which

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers, at Estes Park, Colo., June 1936.

Author: Professor of irrigation investigations and practice, University of California. Mem. ASAE.

must precede such construction. If questions of the irrigation requirements of different crops, irrigation practice, irrigation laws and institutions, irrigation organization, and kindred subjects are involved, the assistance of the Bureau of Agricultural Engineering of the U. S. Department of Agriculture and the state agricultural experiment station is likely to be requested. I think we all appreciate how important are these questions of irrigation economics; the most careful use of water and its application only to land whose products, in competition with the products of other areas, including those of the humid sections, will justify the added costs of irrigation. In matters relating to water supply, whether surface or underground, and also in topographic mapping, the cooperation of the U. S. Geological Survey is obtained. In fact, cooperation between the states and the two last-named of these federal agencies has been a continuing procedure in most, if not all, of the western states for many years. With the increased pressure within the states for comprehensive land and water planning, and the difficulty of obtaining state appropriations in sufficient amount to do the work thoroughly, the tendency to throw a large part of the burden of water planning on the federal government, through the Bureau of Reclamation, the Bureau of Agricultural Engineering, and in some instances, the army engineers, or through the National Resources Committee, in case that important agency is continued, seems likely to increase.

COOPERATION BETWEEN THE FEDERAL AND STATE GOVERNMENTS NEEDED

While it does not appear desirable to develop any federal procedure in planning the use of our irrigation resources which will interfere with or weaken the activities of the individual states in such matters—and perhaps there is very little likelihood of this being done—there is a very definite field for federal participation in this very important work. The current nation-wide regional studies of water resources and water-development needs by the National Resources Committee, being made in response to the request of the President for a water plan that can be put into action, is an example.

In so far as this and similar federal activities have for their chief purpose the development of the lands and waters of specific streams or basins, the states are necessary parties, and cooperation of both agencies is essential. Fortunately the current study by the National Resources Committee referred to is being decentralized as much as practicable, and is conducted in close contact with state officials, including the state planning boards, and is in every sense a cooperative undertaking. The states have been living with their water problems for many years, and must continue to do so. They have a responsibility for their best solution which they can not shift to the federal government, yet they can not do the job as it should be done without the assistance of the federal government.

The states are also directly interested where federal planning has for its primary purpose the development of policy, both as to federal control of waters within the federal sphere of authority and responsibility, and as to the appropriation of federal funds and the selection of projects. In the past there has been some difference of opinion on these matters of federal policy, and to some extent such difference still exists, but happily the federal point of view as to the interests of the states is coming more and more to conform to that held by the states. If this is the fact, it is immaterial whether ground is being given by the federal government or the states. As was brought out in the recent Mississippi Valley report, planning can not be imposed on the people; the government can not dictate, except, of course, as to the appropriation and use of federal funds, and as to matters clearly within the federal jurisdiction.

NATURE OF THE PLANNING NEEDED

While broad, general plans for the use of our irrigation resources are desirable, and in some cases, what are most needed at the time, planning usually is of little final value unless it is carried out in sufficient detail to permit the making of reasonably safe estimates of cost, unless it gives practical consideration to other desirable uses of the resources dealt with, and unless it views both physical and human factors in a realistic way. And then when due weight has been given to all of these matters, and a satisfactory plan has been evolved, there are still important questions to be considered. Are there legal limitations, and, if so, how can they be overcome, or, perhaps, is it desirable that they be overcome? Is the cost justified by the anticipated results, and, if so, how can it be distributed so as not to work undue hardship on those who will be called on to pay? If all of these questions can be resolved satisfactorily, we still do not have the answer. Can the money needed to put the plan into effect be obtained? We already know

"THE IRRIGATION RESOURCES OF OUR WESTERN COUNTRY AND THE MANNER, PLACE, AND MEASURE OF THEIR CONSERVATION AND USE MOST LARGELY CONTROL THE COURSE OF OUR WESTERN CIVILIZATION"

that to carry out any important comprehensive plan for the use of irrigation resources, public funds generally means federal funds, although it is believed the states will find it necessary to take over some of the financial burden of construction in the future. Would some other use of these public funds bring larger or more desirable benefits, or benefits to more people?

Working out plans for comprehensive use of irrigation resources thus becomes a very complicated matter. It is no job for inexperienced and untrained men. It requires infinite patience and intelligence, and a thorough understanding of things as they are, and as they are apt to be, rather than as we might like to have them. Yet, in spite of all of the difficulties, planning the use of our irrigation resources is worth its cost, because the permanent welfare of the entire West is involved; and in so far as supplemental irrigation in the humid and semi-arid regions is desirable and practical, thorough planning is of very great importance. Frequently, suggested plans, each at first seemingly satisfactory, must one after another be discarded, because something not considered has turned out to be important, or because some entirely new condition has arisen that needs to be taken into account. Planning, if it is to be most successful, thus becomes a continuing process.

It is clear, therefore, that comprehensive plans for the use of our irrigation resources are rarely if ever overnight creations, but rather the culmination of the successive thought of many people over a period of months or years, and under rapidly changing economic conditions and requirements.

PLANNING ON INTERSTATE STREAMS

There is a type of planning the use of irrigation resources which has been started within the present year in the basin of the Rio Grande under the leadership of the Water Resources Committee of the National Resources Committee, and which, if successful, as it must be, will inaugurate a new approach to the settlement of rights to water on interstate streams, which is a very important part of planning the use of our irrigation resources. What has been undertaken is an exhaustive fact-finding study, such as must be the basis of any effective planning. Beside the Water Resource Committee, which includes representatives of the Bureau of Reclamation, the Geological Survey, the Corps of Engineers of the Army, the Biological Survey, the Soil Conservation Service, the Public Health Service, and the Federal Power Commission, there have been brought into active participation in the prosecution of the more important phases of the study in the Rio Grande Basin the Geological Survey, the Bureau of Reclamation, and the Bureau of Agricultural Engineering. In addition, the Indian Irrigation Service, the Resettlement Administration, and the Soil Conservation Service are cooperating in special matters within their respective fields of interest. And, as must be the case in every such planning venture involving lands and waters and related resources, the states directly concerned are necessary and very important parties. They have each contributed, or anticipate contributing, to the fund of approximately one-third of a million dollars which has been budgeted for the investigation. They are also heartily cooperating in its prosecution.

For seven years the three states of Colorado, New Mexico, and Texas attempted to adjust their differences over the waters of the Rio Grande, but each successive effort seemed to end in a virtual impasse, principally, it has been thought, because there had been no disinterested collection of all of the relevant data essential for an understanding. Although not being considered in the factual investigation now under way, there are, of course, other matters on which agreement between these three states is necessary, but certainly the facts being gathered are the first requisite.

Among the fundamental questions that have arisen in the past in connection with interstate streams are whether a state owns all of the water that originates within its boundaries and can use it regardless of the needs of the states below, whether the western doctrine of prior appropriation holds across state lines, and whether, if neither of these principles is exclusively to rule on interstate streams, an equitable apportionment between the states is possible.

Generally speaking, the doctrine of absolute state ownership of water is no longer stressed in the case of interstate streams, and the doctrine of prior appropriation and the principle of equitable apportionment are accepted as the proper basis for determining such matters. But there are practical difficulties in enforcing the doctrine of prior appropriation across state lines, as well as in agreeing on what constitutes an equitable apportionment. Unfortunately, none of our important western interstate streams are free from uncertainties as to the rightful or equitable interests of the states through which they flow. However, some feel that the necessities of the situation will lead to such mutual understanding as will result in composing these difficulties without recourse to original suits in the United States Supreme Court, and furnish a basis for administration of rights on interstate streams as sensible and effective as is the administration of intrastate streams under the better of our state water administrative systems. Trying to work out these complicated questions in a manner that will be satisfactory to the states is, as has already been stated, part of the planning of the use of our water resources, for effective planning on interstate streams is not possible until questions of where the water is to go are settled.

SUMMARY OF PRINCIPLES

Enough has been said, it is believed, to make it clear that the irrigation resources of our western country and the manner, place, and measure of their conservation and use most largely control the course of our western civilization. We have important forests and fisheries, our grazing lands supply the bulk of the nation's sheep and cattle, mining is a major industry from Canada to Mexico, and wild life and recreation resources are widespread and distinctive. Yet, without the agriculture which our irrigable lands and waters make possible, many of our towns would be mere trading posts or non-existent, and most of our cities would be towns. We could not afford the fine highways you travel when you go to the Yosemite or the Grand Canyon or to Lake Tahoe, or even to this beautiful Estes Park. We might have three transcontinental railroads, but certainly not the seven which now carry to you our fruits, our grain, and our many other agricultural products, or bear you in air-cooled luxury across the plains and the intermountain country to the Pacific Northwest and Southwest.

It is also believed that the truth has been made clear not only as to the need for planning the use of these irrigation resources, but that the West has long been on the job, is on the job now, and is anxious and ready to cooperate with the federal agencies, and that the task is difficult, expensive, and complicated. This paper might well, therefore, be closed with a mere statement of some of the policies or principles of planning which already have been adopted, or which it is believed most of us will consider both sound and desirable.

1 Since water is the limiting element in agricultural development in western America, control of its use is the key to land and water planning.

In the arid region, control of the use of water lies with

the states, except as limited in a few states by the rights of riparian proprietors, by treaty with a foreign government, or as there is federal jurisdiction over navigable rivers, over rights of way over the public lands and in national parks and forests for canals and other works for the control of waters, as now chiefly exercised under the federal power act, and over unappropriated water on the public lands.

Because there is a twilight zone between federal and state authority over waters, also because there often are both federal and state interests, and because the states are generally not financially able to do all that is needed, cooperation between the federal government and the states, and a substantial measure of federal aid, are essential.

2 While in practice the primary function of the states in the control of water has been to insure its economical use, and through orderly administrative procedure to make water rights certain and secure, they have the additional function of protecting the largest public interest in the use of the water resources.

This is a somewhat indefinite function, because what constitutes the largest public interest is not always clear.

However, the constitutions or laws of thirteen of the seventeen western states give the state water administrative agency authority to reject applications to appropriate water when such appropriation is adverse to the public interest.

More complete planning of the use of our irrigation resources is likely to lead to a clearer understanding and definition of what constitutes the public interest, and to a wider exercise of the authority sought to be accomplished under these laws, than there has been in the past.

3 Because of the relative scarcity of water in the West, the federal government and the states, within their respective or overlapping fields of jurisdiction, will be justified, as far as legally, financially, and economically possible, in requiring that water be used in the manner and in the places that will most nearly result in the best coordinated use when viewed from the standpoint of the economic and social values created; provided, that costs of following out the plan are equitably assessed in accordance with the accruing benefits, including the assessment against the federal or state or local governments of indirect and intangible benefits which are over and above benefits, whether direct or indirect or intangible, that accrue in the main to those who use the water, or to others whose interests are visably and measurably enhanced thereby. That there are these general and indirect benefits from comprehensive and coordinated development which users of water and hydroelectric power directly benefited can not or should not wholly pay is becoming more and more clear. An increase in taxable values, enhanced franchise values to public utilities, enlarged opportunities for business, manufacturing, and commercial activities; equalizing opportunities for local or regional development, flood control in some instances, enlarging the opportunities for rural rehabilitation and resettlement in the general program of national social betterment, are among these general or indirect benefits. How to evaluate and allocate these benefits so that the burden of costs may be equitably spread has not yet been worked out, but it is all part of our problem of planning the use of our irrigation resources.

4 Economic considerations will, in the long run, result in water being used where it adds most largely to values; i.e., where it is worth most. But as we go along there are enough exceptions to this, such as the frequent use of portions of a limited supply of water on inferior land, or its wasteful use, or its use for power where irrigation would satisfy more human wants, to justify all the safeguards possible against their being repeated. While in some situations the sum of the private interests approximates the best public interest, clearly this is not always so, and this fact is one of the more important reasons in favor of planning.

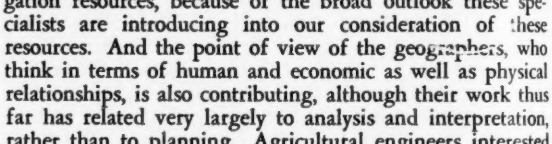
5 Facts are the *sine quo non* of planning. The latter will be effective in proportion to the extent of the former, and the completeness with which they cover all relevant conditions and interests. Primary investigations and research, mainly under governmental auspices, are therefore a necessary part of any planning program.

6 In the field of irrigation resources there is need for a larger measure of planning in the case of small as well as large units than is now exercised, and the same basic principles will apply to the one as to the other, viz., that the costs shall not exceed the sum of the benefits, and that each important alternative use of the irrigation and related resources is to be considered and weighted in terms of permanent rather than only immediate values, in terms of the widest distribution of the benefits that is economically feasible, and in terms of the most equitable allocation of the costs that it is practical to attain.

It is true that in the smaller units there is less incentive to planning than where large areas are involved, and since in such cases the costs will be met almost entirely, if not entirely, by interests directly benefited, those interests will desire to decide what is to be done. Nevertheless, many instances might be cited in which this larger measure of planning of small projects is both desirable and feasible. It is being accomplished to some extent through the control set up by the states, but even here federal help in the planning may be appropriate.

7 The principles of land utilization as they are gradually being developed by specialists in that field give promise of lending great assistance in the best planning of our irrigation resources, because of the broad outlook these specialists are introducing into our consideration of these resources. And the point of view of the geographers, who think in terms of human and economic as well as physical relationships, is also contributing, although their work thus far has related very largely to analysis and interpretation, rather than to planning. Agricultural engineers interested in planning the use of our irrigation resources will increase their influence in this field if they raise their sights high enough to become familiar with what these other thoughtful groups are envisioning.

(NOTE: The author is indebted to W. W. McLaughlin, of the USDA Bureau of Agricultural Engineering, and H. H. Barrows, of the University of Chicago, for helpful suggestions in connection with the preparation of this paper).



THE FARMER ON IRRIGATED LAND IS DEPENDENT UPON THE WATER SUPPLY AVAILABLE IN DRY YEARS

Moisture Content at Which Alfalfa Leaves Shatter

By Frank. J. Zink

DURING the period of curing alfalfa hay the rate of moisture loss from the leaves is more rapid than the rate of moisture loss from the stems. This characteristic difference in the rate of drying of the two constituent parts of the plant results in the leaves becoming overdry, while the stems contain more moisture than is the safe content for storage. When the leaves become overdry, they are susceptible to shattering and loss in the ordinary processes of taking the hay into storage. Such losses accrue through any form of agitation, but principally from mechanical handling.

The loss of leaves while curing and handling accounts for a considerable loss of nutrient value of the final product. The amount of leaf loss is extremely variable. It is influenced by a number of factors, or combination of factors dependent both on machines used in haymaking and climatic conditions while the hay is being handled. The loss of leaves has been noted by many investigators, but quantitative measures of actual extent of loss have rarely been made. Of those reporting, the data of Salmon, Swanson, and McCampbell[1] are rather extensive. They report that over seven seasons of cutting, including four stages of maturity in each of the subsequent crops, an average of 19 per cent of leaves were lost. This loss varied from 2.3 to as much as 34 per cent.

Others who have made similar measurements are as follows: Wiegner[2], in Switzerland, reports losses of dry matter varying from 10 to 30 per cent and digestible nutrients from 15 to 35 per cent. Watson[2] in Great Britain reports dry matter losses of 10, 17, and 37 per cent, and protein equivalent losses of 17, 29, and 54 per cent, respectively, in very fine weather, fine weather, and showery weather.

"Save the leaves!" is a very frequent warning in literature dealing with the general subject of haymaking. Some of the suggestions as to means of forestalling such losses have been partially effective. Others are apparently ineffective, possibly due to insufficient basis of fact for the recommendations.

It is considered that, if the conditions of leaf shattering were definitely known, such conditions possibly might be avoided and a better quality of hay thus obtained. Another need for such information is in conjunction with the artificial drying of hay. It is now common practice to take the green hay direct from cutting or in a semi-wilted condition to the drier, whereas if the hay could be partially sun-cured, for instance to 45 or 50 per cent moisture, the heat requirements could be reduced from 60 to 75 per cent, and the fuel cost, therefore, reduced by a similar amount.

A search of literature on this subject, or the general subject of curing hay, does not reveal data on this particular danger point for leaf shattering. Therefore, an investigation was undertaken in the season of 1933 to obtain such data[3].

The method of analysis required a tumbler or rattler as illustrated in Fig. 1. This device consisted of an ordinary 50-gallon oil drum fitted with an axle of 1-inch pipe as illustrated. A rubber gasketed door was fitted at one end of the barrel and constructed so as to latch tightly. A crank welded into the axle completed the unit. As used in this work, it was mounted on sills projecting from the bed of a truck.

The apparatus was charged with a quantity of hay, approximately three pounds being used. A dozen old golf balls were selected as being of about the correct weight and placed in the barrel with the hay for the purpose of increasing the severity of the rattling, or shattering action, and to keep the charge of hay from rotating with the barrel. After charging, the barrel was rotated 100 revolutions at constant speed. This turning required about 4.5 minutes. When the conditions were right for the leaves to break off the plant, the action of the rattling produced the desired result.

Author: Research agricultural engineer, Allis-Chalmers Mfg. Co. Mem. ASAE.

[1]Salmon, S. C., Swanson, C. O., and McCampbell, C. W. Experiments relating to the time of cutting alfalfa. Kan. Agr'l Exp. Sta. Tech. Bul. 15, 1925.

[2]Page, H. J. Farm and Machine Vol. III, Institute for Research in Agricultural Engineering, Univ. of Oxford. England.

[3]Work conducted by the author at the Kansas Agricultural Experiment Station.

FIG. 1 TUMBLER FOR TESTING SHATTERING CHARACTERISTICS OF ALFALFA HAY SAMPLES. MOUNTING ON THE REAR OF A TRUCK PROVIDED THE NECESSARY MOBILITY TO AVOID EXCESSIVE HANDLING OF SAMPLES FROM WINDROW TO TUMBLER

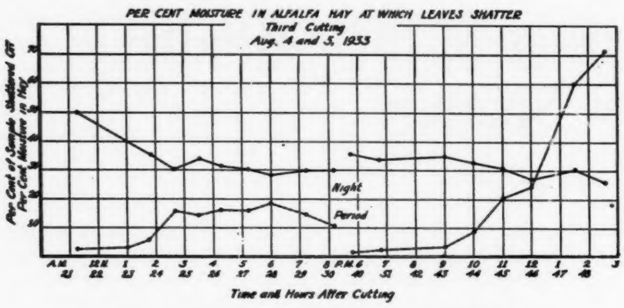
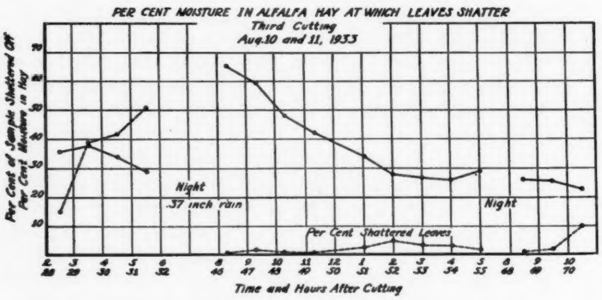
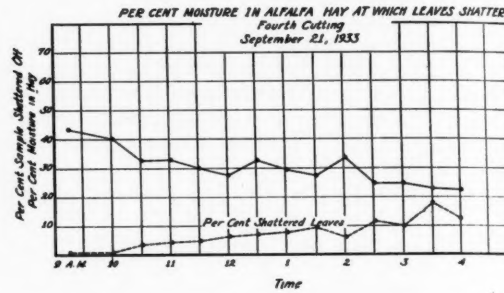


FIG. 2 (UPPER LEFT). FIG. 3 (LOWER LEFT). FIG. 4 (BELOW). THESE DIAGRAMS SHOW THE RELATION OF SHATTERING TO MOISTURE CONTENT AND TIME OF DAY WHEN HAY IS HANDLED, FOR THREE SERIES OF TESTS ON THE DAYS INDICATED





The general procedure of the tests involved taking periodic samples of hay as it dried normally in the swath. The samples were placed in the rattler, and at the end of the requisite number of revolutions, the stems and whole plants were carefully separated from the leaves. The two portions were placed immediately in bags, weighed, and retained for moisture analysis. Moisture analyses were made of the leaf and fine stem parts only, when sufficient material was available for accurate sampling. When damp or uncured, there were but small leaf losses.

Results were obtained on first, third, and fourth cuttings of alfalfa. Seven different records were obtained throughout the season. Of those records, Figs. 2, 3, and 4 are selected as being of greatest interest.

In Fig. 2 it may be noted that leaf losses became more severe as the hay approached 30 per cent moisture. After 6:00 p.m. there was a noticeable tendency for the leaves to toughen and losses to decrease, although there was no marked change in total moisture content of the hay. On the second day, August 5, general arid conditions existed and leaf losses became excessive between the hours of 11:00 a.m. and 3:00 p.m., although the general moisture condition of the remaining portion of the sample did not change more than about five per cent.

Fig. 3 shows results which point to soil moisture as a very significant factor. General arid conditions produced high leaf losses the first day although the hay contained about 35 per cent moisture. A light fall of rain during the night brought the moisture back up to about 65 per cent. Only small amounts of leaf losses occurred in spite of the fact that the hay reached nearly 25 per cent moisture at 4:00 p.m. It was not until about the middle of the second day following the rain that leaf losses again became excessive.

In Fig. 4 are shown results obtained in September under less arid conditions. The drying rate is notably slower than was found earlier in the summer. Leaf losses were less and did not occur until the hay was somewhat below 30 per cent moisture.

These trials were not influenced by dew except in the October tests. However, there was a marked tendency for the shattering losses to decrease around 4:00 p.m., and a very definite tendency for losses to remain low in the mornings up to about 10:00 a.m.

From these results it would appear that as alfalfa hay approaches 30 per cent moisture (wet basis), there is considerable danger of losing leaves. This moisture is higher than that considered safe for storage. This danger, however, depends upon the factors of humidity, temperature, and ground moisture, as probable influences on the brittleness of the alfalfa. These factors possibly are reducible to one direct factor, that of humidity, prevailing in the level or position of the hay.

Because of small samples of shattered material, moisture analyses were not practicable in many cases. In those cases where analysis was possible, the moisture content ranged around 10 per cent (wet basis). To determine this point more accurately, several samples of leaves which were shattered from alfalfa during ordinary handling operations, were obtained. Of five samples thus secured, the range of moisture content was found to be from 9.3 to 11.8 per cent. From these data it would appear that leaves shatter when they approach an air-dry condition of approximately 10 per cent moisture and apparently have a rather narrow range of moisture content when they are susceptible to separation from the main plant.

In conclusion, the author considers that under the conditions of this test, shattering occurs, or the hay is in a condition for shattering, even before it is sufficiently dry for storage. The data indicates the possibility of night, including evening or morning operations, as a means of securing improved quality of hay. This procedure is supported in practice especially in Arizona where night working in the hay fields is in vogue.

As a further conclusion, it appears possible, where hay is dried artificially, to permit the hay to remain in the field without loss of dry matter until an average moisture of around 40 per cent was reached, thereby effecting considerable fuel economy.

Preparation and Presentation of Extension Subject Matter

By J. P. Fairbank

PREPARATION of subject matter for agricultural engineering extension is largely a matter of time. Reservoirs of information on most any subject are available to everyone. The problem is to find the time to extract from the many sources those portions of information which are desired. Since the supply of time is less than the demand, the selection of a subject to work on is of primary importance. The subject must be worth the expenditure of sufficient time to do a good job. The preparation of subject matter for a poor project may require as much effort as for a good one. A good extension project, in my opinion, should meet most of the following requirements:

1 Promote the adoption of practices having real merit and practical application
2 Apply to a large area or to many people
3 Embody simple subject matter which can be clearly demonstrated
4 Be capable of results which can be measured.

Subject matter for extension use as we now know it should be primarily selected with a definite object in view, namely, to aid farmers in arriving at conclusions which will lead them to adopt good practices or to discontinue poor ones. A secondary object is to instruct them on essential details pertaining to the successful use of a new practice.

Subject matter most in demand is that which shows how to do a thing better, cheaper or easier. If all three advantages are marked, the adoption of the practice is rapid and the way of the extension man is strewn with roses.

Extension methods merit consideration, but it is most important to have worthwhile subject matter to extend. This brings us back to our reservoirs of information. Obviously, the first is our subject matter department and experiment stations, both agricultural and engineering. So far as I know, all extension agricultural engineers in public service are either members of the department of agricultural engineering of their respective institutions, or work in close accord with them. This gives the extension man the opportunity of keeping informed on the findings and recommendations of his subject matter department. Further than that, he should have a general knowledge of the major research projects of other divisions which may have a bearing on present or future agricultural engineering work. With the heavy field schedules common to the extension engineers, keeping posted on developments of other states and countries is difficult. When he returns from a field trip he finds his desk piled high with letters, governmental and trade literature, and questionnaires. About all he can do, after the letters are answered, is to file the literature which may be of future use, and check the announcements of publications which may be useful and have them ordered.

AGRICULTURAL ENGINEERING and the "Experiment Station Record" are, for me, the best sources of information on publications which may be of use in the preparation of extension subject matter. Some of the trade literature is useful in that it keeps one informed on machines and materials which are offered on the market. Some of it is useful to the extension man only in that it shows him what arguments are being used to induce farmers to buy this or that. On the other hand, a limited amount of trade literature is of a technical and factual nature which is of real subject matter value.

The extension engineer cannot rely solely on literature for his subject matter. As with everyone else, he has his own experience and observations to draw from. There are the unpublished findings of research workers which may be used in some cases. Many farmers and mechanics are born experimenters and have a wealth of information gained from experience with their local conditions. The extension engineer, by cultivating the acquaintance of these men, taps a huge reservoir of information. Because of this fact, a survey in the form of personal interviews may be justified as one of the first steps in preparing the subject matter for a project. Information gleaned from such a survey may also be useful to the experiment station by indicating the importance of some problem, what attempts have been made by local people to solve it, what methods of attack have proved unsuccessful, and what methods show possibilities. I am fully aware that the extension man may not be a research worker, but he needs sound and practical subject matter to extend. If his field contact will aid the subject matter department or experiment station in arriving at acceptable solutions of problems, such assistance may well be considered as a part of his job. The extension agricultural engineer may in some cases help with experimental work on a project which he is to extend. This gives him a familiarity with the subject which begets confidence when he presents it in the field.

The extension engineer should know more about a subject than he intends to present. It is essential that he know the background of the subject, the findings and opinions of other workers, and minor limitations which, if included in a publication or a speech, would serve only to confuse the reader or listener. This background prepares him to answer the unexpected questions.

My practice in preparing subject matter is probably no different from the ordinary. I merely gather up all the references on the subject that I can find, scan them, and select those which apply. A preliminary study shows the subheads into which the subject is divided. Then I laboriously excerpt the pertinent statements or data, placing together all items covered by a given subhead. This so brings together data and opinions that they may be quickly compared. Under these same subheads is included the information obtained from sources other than that in the literature. Having in mind the purpose for which the final subject matter is to be used, the gaps show up. Steps can then be taken to bridge the gaps by further search of literature, additional experimental work, or surveys.

Presented before the College Division at the annual meeting of the American Society of Agricultural Engineers, at Estes Park, Colo., June 1936.

Author: Extension specialist in agricultural engineering, University of California. Mem. ASAE.

After compiling and classifying information, the urge to use all of it must be suppressed and a selection made of a few major points. "Everything else being equal," says A. B. Graham, subject matter specialist of the USDA Extension Service, "the number of persons who will adopt a recommendation varies inversely with the number of points of complexity in the recommendation itself."

Brevity is one of the essentials of extension subject matter. A limited amount of data or description of experimental work may well be presented to give confidence in the validity of the conclusions, but we must remember that we are preparing it for busy people who are interested mainly in the answers. Not only is the time of our listeners restricted and valuable but the particular subject under discussion is only an incidental thing in their existence; they have many other things on their minds and are not interested in all the ramifications of the subject, as is the man who wrote the book.

I wish to cite two excellent examples of research and extension publications. Ohio State University Bulletin 490, "Feed Grinder Investigations," by E. A. Silver, is a splendid piece of work of a research nature. It is a gold mine of information for the extension engineer who is preparing a project on feed grinding, but it was probably not written with the idea that it would be widely read by farmers. Relatively few would take the time to give it the careful study it deserves.

University of Nebraska Extension Circular 713, "The Trench Silo in Nebraska," by Ivan D. Wood and E. B. Lewis, is, to my way of thinking, a fine extension publication. It is well illustrated, short, gives some experimental data to support the conclusions, and clearly tells the farmer what he wants to know about trench silos.

Publications which are short and concise need not be of inferior quality. Short statements, definitely to the point, yet unlikely to be misinterpreted, require more careful preparation than do long ones. I have spent more time preparing a fifteen-minute radio talk than on a one-hour lecture covering the same points.

The mimeograph is a useful form of extension publication. In California, we have an "Agricultural Engineering Information Series" on timely subjects. These mimeographs are used not only to answer requests for information but also for distribution at meetings. The main points of the subject matter presented are contained in them. The county agents use the mimeographs in preparing their publicity before and after the meetings.

MANNER OF PRESENTATION IMPORTANT IN SECURING EFFECTIVENESS

My remarks on the presentation of extension subject matter will be confined to lectures and demonstrations to groups of people.

An uncomfortable audience is a restless one. People do not like to stand through a lengthy speech. A seated audience is not only more attentive, but individuals stay put so that the speaker can spot those to whom he especially needs to address his remarks. The problem of seating at a field meeting in a farmyard requires some ingenuity in using available materials such as lug boxes, planks on saw-horses or chunks of wood, bales of hay, wagons and hayracks, or cars lined up in a semicircle so that people can sit in them and on the running boards. This latter method is helpful in a raw wind. If a cold wind must blow, may it be from the north so the audience can back up against the south side of the barn, out of the wind and in the sun. Let the audience look away from the sun or open doors and windows. White charts exposed to direct sunlight are hard to look at. A warm day, a lawn and a big shade tree or two is a fine set-up for an outdoor meeting. Noises distract both the audience and the speaker, hence a thought to avoid a meeting beside a busy highway. The county agent must be depended upon to tactfully adjourn conferences on the outskirts of the crowd. Little can be done about dogs, except to declare a recess until the fight is over.

What we have to say or show is a waste of time unless the audience can hear, see and understand what we are presenting. Obviously, it is of primary importance that we get attention at the outset and hold it. The speaker has the attention of the audience the moment he is introduced, because curiosity is a common human trait. To hold attention he has merely to keep the group interested in what he is saying or showing. Opening statements and mannerisms make important first impressions. The speaker wants his listeners to relax with the feeling, "This is going to be good"; not to settle down with an "How long will he talk?" attitude. It is not my purpose to discourse on public speaking, but it is my observation that the first essential is to speak loud enough. This very obvious rule is violated by many speakers. If a prospective listener finally asks the speaker to talk louder, he may do so for a few sentences and then drop down to an undertone which exasperates the people in the back of the room or on the outer edges. They try to pay attention for awhile, then give it up as futile.

Dry subject matter is made easier to take by judicious moistening with a little humor. A few chuckles now and then help to hold attention and need not cloud the sincerity of the speaker. Laughs at the expense of individuals or nationalities must be used with caution.

Some kinds of subject matter, such as rural fire prevention, can be effectively presented by dialogue. The audience is then "listening in," not "being told." The conversation and arguments must be natural, not stilted; the leads and replies should seem spontaneous and not memorized.

Illustrative materials aid in holding attention, as well as to clarify the discussion. Agricultural engineering subjects lend themselves admirably to the use of illustrative materials, such as slides, strip films, motion pictures, models, and actual machines, devices or materials.

Several years ago a farm implement manufacturing company headed an advertisement with the caption "One Look Is Worth a Thousand Words." The ratio may not be a thousand to one, but it expresses a point which should be considered in the presentation of extension subject matter.

The construction and use or operation of farm structures, machinery, and devices may, in some cases, be more clearly, and certainly more quickly, shown to groups by means of motion pictures, than by any other way. Unfortunately, the preparation of a really good motion picture is rather costly and a wide use of it must be assured to justify the time and expense involved. We have found few commercial films entirely suited to our needs.

USE AND MISUSE OF CHARTS

Charts can be very helpful in the presentation of subject matter, or they may be an impediment. Too often the charts serve mainly as a set of notes for the speaker who reads them to the audience. They should be used only to clarify or emphasize important points. It is futile to put masses of data on charts and expect the audience as a whole to see and understand them. The use of a few charts often serves a good purpose but they should be simple, tell a definite story and be large enough to read. Fifty feet is the maximum distance at which *(Continued on page 366)*

Unit Heaters in Greenhouses

By Arthur H. Senner

THE USE of unit heaters in general industrial heating is increasingly common and perhaps everyone associated with the heating industry is familiar with such applications. The use of the unit heater in greenhouse heating is not very common, however, and it is no doubt true that many seasoned heating men have never seen a greenhouse heated by this type of equipment. The scientists of the U. S. Department of Agriculture have for several years appreciated certain advantages of the unit heater and have utilized it in the growing of some crops. In the commercial field, the Weiants of Newark, Ohio, were the first, in the knowledge of the author, to apply unit heaters to greenhouses. In the field of scientific research H. H. McKinney, senior plant pathologist of the Bureau of Plant Industry, U. S. Department of Agriculture, was one of the earliest users of unit heaters. Some of the chief advantages which have been claimed for unit heaters in greenhouses are (1) relatively uniform temperature distribution, (2) very little shading of the crops, due to small, compact heating units with only a minimum of piping, (3) ease of control through simple automatic devices, and varying the speed of the fan, (4) flexibility, enabling the temperature to be raised or lowered quickly, and (5) a gentle air motion advantageous to crop growth, provided by the circulation fan.

Others have claimed that the temperature distribution with properly arranged coils is more uniform than with unit heaters. They grant the claims regarding shading of crops, ease of control and flexibility. They maintain, however, that the air motion is objectionable when the plants are high enough that the warmed air blows directly on them. This last point appears to be one of the most serious criticisms of unit heaters. Thus far the only applications of unit heaters made by the author were those in which the plants were short enough to be below the current of warmed air, as it first left the heaters.

Mr. McKinney, when using unit heaters, takes advantage of the fact that the greenhouse side walls are not necessary for the support of the displaced heating coils, and accordingly replaces a portion of the ordinary masonry side walls by glass, thus decreasing the shade in the house. One of the principal advantages of the unit heaters, in Mr. McKinney's opinion, lies in the fact that the temperature can be regulated readily by the use of a simple line-voltage thermostat which controls the operation of the motor.

A study of unit heaters in greenhouses made by the Bureau of Agricultural Engineering, and reported herein, does not presume to answer all questions pertinent to the subject. It should be regarded, rather, as only one phase of a more general investigation that should be continued when opportunity is presented.

The objects of this study may be stated briefly as follows:

1 To determine the relative steam consumption of unit heaters and conventional pipe coils for heating a greenhouse.

2 To compare the distribution of temperature with the two types of heating.

3 To determine the relative quantities of steam required during the daylight and night periods, respectively, and to arrive at a knowledge of the steam consumption per degree-day per 1,000 square feet of equivalent glass area.

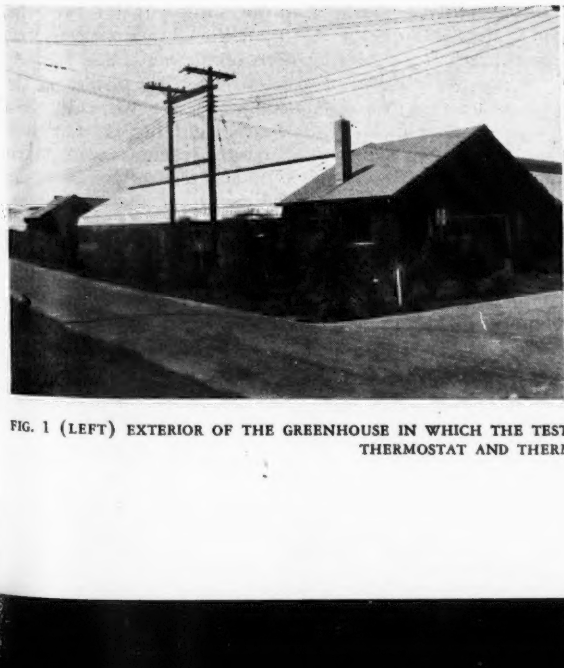
Item 3 has no particular bearing on the merits or demerits of the system involved and was included, because the Department of Agriculture is frequently confronted with the problems of estimating probable seasonal fuel requirements for some of its many greenhouses, and so far as the author knows there are no data available on this subject.

It cannot be overemphasized that the results reported hold strictly only for the conditions of the test. The greenhouse is comparatively new. The unit heaters are of a definite type as described below.

The investigation was conducted in a greenhouse ordinarily used for the study of sugar beets by the Division of Sugar Plants of the USDA Bureau of Plant Industry at Arlington Experiment Farm, Rosslyn, Virginia. The greenhouse (See Figs. 1, 2, and 3) is 100 feet long, but is divided into two 50-foot sections. These tests were conducted in the south portion, which is farther from the headhouse.

Some 3,340 square feet of glass or equivalent inclose

Author: Associate mechanical engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture.



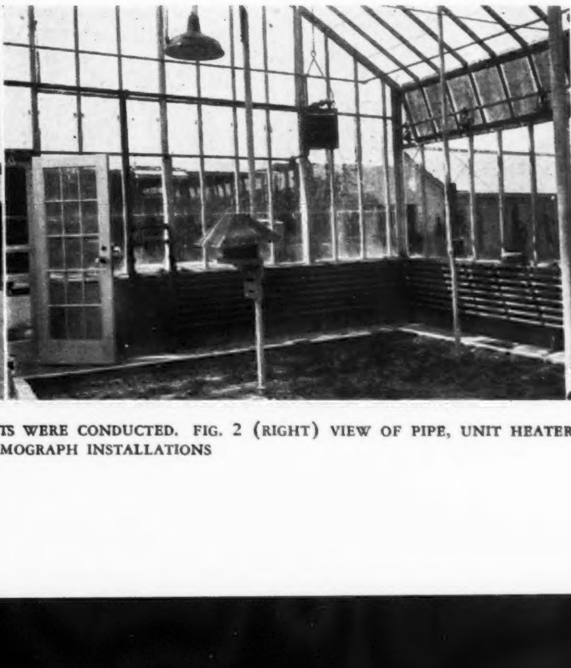
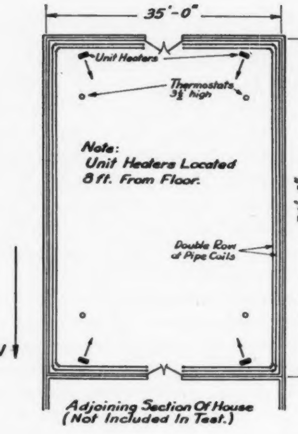


FIG. 1 (LEFT) EXTERIOR OF THE GREENHOUSE IN WHICH THE TESTS WERE CONDUCTED. FIG. 2 (RIGHT) VIEW OF PIPE, UNIT HEATER, THERMOSTAT AND THERMOGRAPH INSTALLATIONS



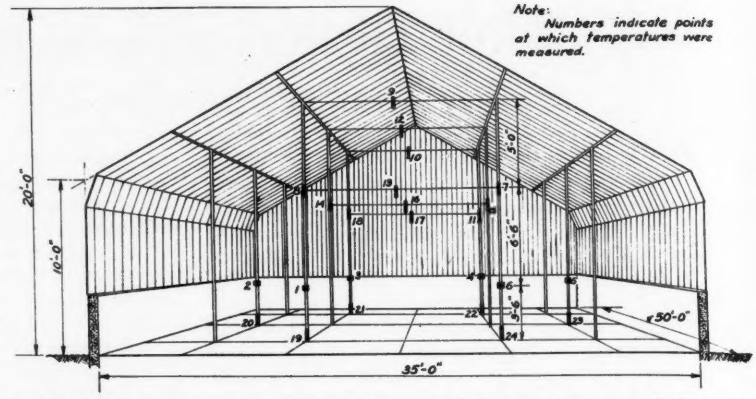


FIG. 3 (LEFT) PLAN OF SECTION IN WHICH TESTS WERE CONDUCTED. FIG. 4 (RIGHT) PERSPECTIVE OUTLINE SHOWING POINTS AT WHICH TEMPERATURE READINGS WERE TAKEN

the greenhouse. Each 2 square feet of concrete wall is considered equivalent to 1 square foot of glass in heat loss and this is added to the actual glass area in computing heat requirements. It is 20 feet high, to the ridge, and the side walls consist of 2½ feet of concrete and 7½ feet of glass, making a total sidewall height of 10 feet. The southern end of the portion of the house used for test is exposed and the northern end is considered unexposed because it is separated from the adjacent half of the house by a glass partition. The temperatures in the two halves are always approximately equal, so there is no appreciable exchange of heat between the two. As stated above, the house is not very old, having been completed in 1932. This has some bearing on the heat loss, and consequently on the amount of steam and fuel required.

The house is ordinarily heated by steam in two rows of eight 1¼-inch pipes on each side of the house and extending around to the door as shown in Figs. 2 and 3. Steam is supplied by a central boiler plant of four 150-HRT (horizontal return tubular) boilers. This boiler plant also provides steam for other buildings on the experiment farm. The condensate is returned to the boiler by means of a vacuum pump located in the boiler room. As may be seen from Fig. 2, there are adequate control valves on the pipe coils for the manual regulation of temperature. This regulation is performed by watchmen who make periodic rounds throughout the night and open or close the control valves on the pipe coils depending upon the demand for steam as indicated by the greenhouse temperature.

Four unit heaters, one of which can also be seen in Fig. 2, were used. Each of these was controlled automatically by a line-voltage thermostat located as shown in Figs. 2 and 3. They are of the suspended type, without recirculating boxes, having single fan speed of 1725 revolutions per minute, and each is rated at 73,000 Btu per hour with an inlet air temperature of 60 degrees (Fahrenheit), this being the equivalent of 304 square feet of direct steam radiation. This amount of unit heater capacity should be capable of maintaining a temperature difference of approximately 70 degrees between the inside and outside of the greenhouse. Fig. 3 shows the direction of the air currents from the unit heaters.

Steam used for heating the house was measured by means of a condensate meter placed in the return line. The meter was so valved that it could be used to measure the condensate from either the coils or unit heaters depending upon which was in operation. Locations of the thermostats controlling the several unit heaters are shown in Fig. 3. Each thermostat controlled the unit heater closest to it. Thermographs and mercury thermometers were placed at various points throughout the house. Locations and numbers of these temperature stations are shown in Fig. 4.

Principal readings in the conduct of this test were the daily ones of quantity of steam consumed and temperatures. Readings of the condensate meter were made in the morning, generally at 9:00 o'clock and again in the afternoon, generally at 4:30 o'clock, although at the beginning of the tests the readings were taken at 6:00 a.m. and 6:00 p.m. At any rate it was thereby possible to subdivide the total steam demand into the portion required during the daylight hours and the portion required during that part of the twenty-four hours when the heating effect of the sun was either zero or very nearly zero.

The six thermographs each recorded the temperature for a period of one week, after which a rewinding and change of chart was necessary. The thermograph records at the six points were the only temperature readings obtained during the routine tests which were begun November 20, 1933, and terminated April 2, 1934, during which time the house was heated alternately by unit heaters and pipe coils in order to yield comparative data. The alternate periods of heating by unit heaters and coils were each of two weeks duration, with one exception at the end of the test when the unit period was only one week, as shown in Table 1.

Twice during the investigation special comparative tests were made to determine the temperature distribution throughout the house, when operating with the two types of heaters. During these tests, additional thermometers were suspended in different portions of the house and frequent readings were made in order to learn the nature of the temperature distribution pattern. These particular tests were conducted on comparatively cold nights. On these occasions twenty-four temperature readings were taken throughout the house, providing an excellent picture of the temperature distribution. The results of these two runs, designated as special runs Nos. 1 and 2, are presented in graph form.

Relative amounts of steam required to perform a given heating task by the unit heaters and by coil radiation, are of primary interest in determining the economy of the installations. The data presented in Table 1 show the steam requirements per degree difference in temperature between the inside and outside of the greenhouse, and do not take into account economies that would result from the lower temperature regulation shown in Fig. 8.

TABLE 1. RELATIVE STEAM REQUIREMENTS
(Night Operation)

Period 1933-34	Type of heater	Average temperatures, deg Outside	Average temperatures, deg Inside	Difference in temperature, deg	Steam consumed per degree-hour per 1000 square feet of glass, lb
Nov. 20-Dec. 4	Coils	47	63	16	1.05
Dec. 4-18	Unit heaters	37	61	24	1.13
Dec. 18-Jan. 1	Coils	37	65	28	1.14
Jan. 1-15	Unit heaters	40	62	22	1.00
Jan. 15-29	Coils	39	65	26	1.08
Jan. 29-Feb. 12	Unit heaters	21	63	42	1.03
Feb. 12-26	Coils	26	65	39	1.08
Feb. 26-Mar. 12	Unit heaters	34	63	29	0.98
Mar. 12-26	Coils	39	67	28	0.87
Mar. 26-Apr. 2	Unit heaters	46	68	22	0.76

As the table heading indicates, the steam consumption figures and other data pertain to night operation, which was actually for most of the time from 4:30 p.m. to 9:00 a.m. This is not truly night operation, but during the midwinter months at least the heating effect of the sun during this time of the day is not great. Since the results are comparative and the two types of heat were employed alternately during the season, the data should give a fairly reliable picture of the relative steam requirements.

The increasing heating effect of the sun as the days become longer can be seen in the steam consumption figures in the last column of Table 1. These figures increase and decrease as the days shorten and lengthen respectively. For example, during the period December 4 to 18, the steam consumption is 1.13 pounds per degree-hour, per 1000 square feet of glass, whereas during the period, March 26 to April 2 the steam consumption is only 0.76 pound per degree-hour, per 1000 square feet of glass. This decrease is due to the greater heating effect of the sun during the latter period. The somewhat sharp drop in the steam consumption during the period of January 1 to 15 may be explained by a decrease in the infiltration of air during that period.

This material is presented in graph form in the upper curve of Fig. 5. This graph follows the expected form in view of the variation of the heating effect of the sun during the winter season.

By averaging the steam consumption figures for each type of heater and comparing them, it is found that the

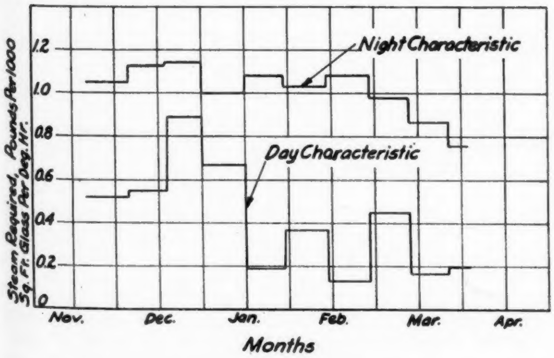


FIG. 5 STEAM REQUIREMENTS DURING DAY AND NIGHT PERIODS

average steam consumption in pounds per degree-hour per 1000 square feet of glass, for the coils, for the period covered by the tests is 1.04, whereas the steam consumption for the unit heaters is 0.98 pound. This would apparently indicate that the coils required 6 per cent more steam to perform a given heating task than did the unit heaters. This apparently means also that the fuel requirements would be higher for the coils to precisely the same degree.

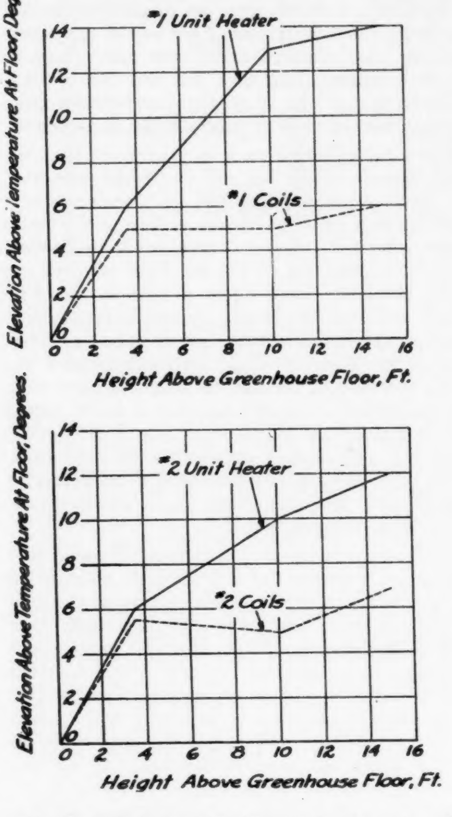
There is one factor which must in fairness to the coils be introduced into the discussion and that is the matter of power cost. It is estimated that the unit heater motors required 530 kilowatt-hours of electricity during the entire heating season, which at a rate of 2 cents per kilowatt-hour represents a total current cost of $10.60. Coal required per season for the particular house under discussion would be 20 tons, which at $6 per ton would indicate a fuel cost of $120 per season. Thus the cost of current means an additional outlay in the operation of the unit heaters of 9 per cent above the cost of fuel for heat by means of pipe coils. This, together with the saving of 6 per cent in steam, means that the net effect is an increase of 3 per cent in the operating cost with the unit heaters, above that for pipe coils. Bear in mind that these figures are for the conditions of these tests only, and extending these results to other conditions must be done with discretion.

It seems quite possible that some of the increase in fuel consumption when operating with pipe coils adjacent to side walls may be due to the radiation of heat to the cold side walls. (In the house where the tests were made these walls were of 8-inch concrete.) This is only a guess which should be checked by experiment. If such a loss is found to be significant a certain amount of insulation on the side wall might be justified. In some greenhouses only a small percentage of the radiation is hung on the side walls, in which case the effect discussed is obviously of no importance.

One of the surprising results of this test was the fact that more uniform temperature distribution throughout the house was maintained by means of the coils than by the unit heaters as they were operated in this investigation. The differences in temperature between the several thermographs which were located at heights of about 3½ feet and spaced pretty generally throughout the house were not significant, but these differences were smaller when operating with coils than when operating with unit heaters.

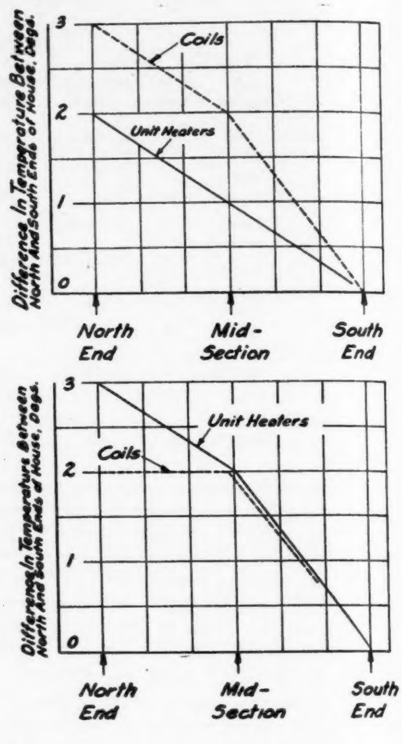
A more striking picture, however, is presented in Fig. 6, which depicts the stratification of temperature in the vertical direction throughout the greenhouse. In order to plot these graphs, the data obtained during the two tests of January 29-30 and February 9, 1934 were employed. During these tests, 24 temperatures were read periodically at various points throughout the house (Fig. 4) to determine the relative temperature distribution when operating with the two types of heaters under discussion. The temperature readings at the several levels were averaged in order to obtain the picture presented. The same general story is told in both parts A and B of Fig. 6. Up to a height of 4 or 5 feet the degree of stratification is approximately the same with both types of heat, but above this level the stratification is much more pronounced in the operation of the unit heaters than in the operation of the coils. For example, in the case of run No. 1, the elevation in temperature at a height of 10 feet in the case of unit heater operation was 13 degrees, whereas with the coils operating the elevation in temperature was only 5 degrees. By elevation in temperature is meant the increase in temperature at any level above the temperature of the floor. At 15 feet, still referring to run No. 1, the difference is more marked, the

FIG. 6 (LEFT) TEMPERATURE STRATIFICATION. FIG. 7 (RIGHT) TEMPERATURE DIFFERENCES, NORTH TO SOUTH. TEST CONDITIONS INDICATED BETWEEN GRAPHS APPLY TO BOTH FIGURES



Run No. 1
Av. Ins. Temp. (3½' Level)
Coils- 61°F.
Unit Heaters- 58°F.
Av. Out. Temp.- 9°F.
Wind Velocity- 13 m.p.h.
Direction of Wind- N.W.

Run No. 2
Av. Ins. Temp. (3½' Level)
Coils- 61°F.
Unit Heaters- 61°F.
Av. Out. Temp.- 9°F.
Wind Velocity- 9 m.p.h.
Direction of Wind- N.W.



stratification being 14 degrees in the case of unit heater operation and only 6 degrees in the case of operation with pipe coils. A somewhat similar story is told by part B of Fig. 6.

Fig. 7 presents additional data on temperature distribution; this data, however, is interesting only in that it shows the difference in temperature distribution caused by the exposure of the south end and the protection offered by the adjacent heated half of the house to the north. Naturally the temperature is higher at the north end but it is somewhat surprising to find a difference of only 3 degrees between the two ends. Neither type of heater has the advantage as far as temperature distribution in a north and south direction is concerned; in run No. 1, the coils show the larger temperature difference, whereas in run No. 2 the unit heaters show the larger temperature difference.

The particular phase of temperature regulation which shows up to advantage in favor of the unit heaters at least for the mode of operation followed in this investigation is depicted in Fig. 8.

The temperature graph in the case of unit heaters is in effect a horizontal line at the predetermined temperature, at least during that portion of the day when overheating due to the sun effect did not occur. The graph of temperature for coil operation, however, is not nearly so uniform. It will be remembered that the temperature during operation with coils was regulated by periodic visits of the night watchmen on their rounds. Obviously the coils might also have been controlled automatically although this is not so frequent as is automatic control with unit heaters, nor are the controls quite as simple or inexpensive as those for the unit heaters. In Fig. 8 the only portion of the graph which should be considered in ascertaining the effectiveness of temperature control is that during the night period when the heating effect of the sun does not prevail. Obviously overruns in temperature when sun is on the glass can not be charged against the temperature regulation in a scheme of this sort.

In a previous section some discussion of steam requirements was made, principally to bring out the relative demands of the two types of heaters. It is interesting also to compare the relative quantities of steam required during the day time and night time in greenhouse heating. The demand for steam should obviously be much less during the daylight hours because of the heating effects of the sun. Figures similar to those given in Table 1 have been prepared for the daylight hours of operation and plotted in Fig. 5 (the lower graph). This figure shows clearly the great difference in steam require- (Continued on page 340)

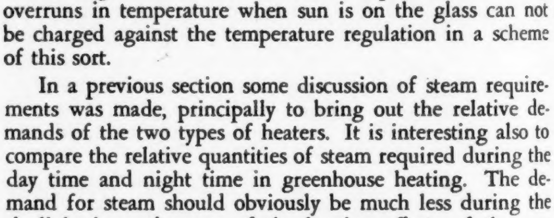


FIG. 8—TYPICAL THERMOGRAPH RECORDS PRODUCED DURING TESTS

Line Extension Policies

By H. J. Gallagher

IT IS but natural that I confine the text of this discussion to the Michigan policies with which I am familiar. In view of the record established in farm electrification in Michigan during the past seven years, together with the increasing interest in farm electrification throughout the country at the present time, a presentation of policies that have worked may be in order.

In 1926 when the Michigan CREA was first established and became operative we found a chaotic condition as far as rural rates and line-extension policies were concerned. It was the period of multiple meters, complicated rates, and barter and exchange in building lines. Some of our largest private utilities, divided into 15 divisions, in many respects operated as 15 different power companies. Some divisions alone had as many as four different plans of extending lines depending upon the type of customer, the density factor, the personal factor, and the political situation. In other words, there was no degree of uniformity throughout the franchized area of any one company, let alone a degree of uniformity in an area served by a member of companies. Practically every extension policy in effect in the United States between 1926 and 1928 was analyzed as to its practicability in Michigan and was rejected, at least by the larger utilities.

Late in the fall of 1928 the Detroit Edison Company filed with the Michigan Public Utilities Commission the extension plan that has since become generally known as the "Michigan Plan."

On February 1, 1929 the Consumers Power Company adopted the same plan. Within a year other utilities did likewise so that by the beginning of 1931 the agricultural area of the lower peninsula of Michigan, in which approximately 80 per cent of our total rural population lives, could get electric service on practically the same basis regardless of the serving company, with the general exception of the public utilities and a few of the small private utilities.

The substance of the "Michigan Plan" and some of the modifications that have evolved, together with personal comments are as follows:

Rural Customers Defined. A rural customer is defined as any customer located outside of the territory served by local urban distribution systems, unless otherwise specifically classified in company's rate schedule.

In this respect all rural customers are not classified as farm customers. The statistical departments of all our private utilities classify a farm customer in accordance with the classification of the U. S. Department of Agriculture.

Application — Right-of-Way — Deposit. When one or more farmers make application for electric service the company will investigate the proposed extension to determine proper location of the pole and wire line, the voltage, phase and type of construction necessary. The applicants shall secure all right-of-ways before the company will undertake to make the extension. Applicants shall also deposit with the company a sum equal to one thousand ($1,000.00) dollars per mile of the proposed extension.

This establishes a uniform price per mile of line throughout the entire territory served by the company and places on the farmer the responsibility of initiating the project and securing right-of-way. It is comparatively simple for farmers to secure right-of-ways in their own community. It is practically impossible for the power company to do so. In 1933 Detroit Edison Company lowered the price on their lines to $750 a mile and in 1934 made a further reduction to $500. Refunds remain unchanged.

Construction of Extension. When applicants have secured right-of-ways and have made the deposit, the company will proceed to build the extension. Construction shall be in accordance with the standard construction rules of the Michigan Public Utilities Commission.

This is in accordance with the national electric safety code. Practically all of the Michigan systems are of the delta type.

The company will furnish and install all transformers and meters and will furnish the service wire to connect the pole and wire line and customer's meters.

Customers shall furnish and install any poles required between the pole and wire line and customers' meters; or, at the option of customer, the company will furnish and install such poles at a price of ten ($10.00) dollars per pole, if the pole is set at the time the extension is being built. If such poles are set after company has completed the construction of the extension the price shall be twenty ($20.00) dollars per pole. The poles furnished will be standard 30-foot poles. It has been my experience that in few instances has the $10 or $20 pole charge been levied.

Customers' Equipment. Any wire, poles or other equipment required beyond customer's meter shall be furnished, installed and maintained by the customer.

Refunds to Original Customers. The company will refund the sum of one hundred ($100.00) dollars for each original customer. An original customer is defined as a customer who is connected to the extension at the time the extension is being constructed and who begins to take service therefrom within sixty (60) days from the completion of the extension. The refund for each original customer will be made within a reasonable time after the first monthly bill for electric service is rendered to such original customer. Additional customers will be defined as customers connected to the line after the extension has been completed. When each additional customer has been connected to the extension, and when he begins to take service therefrom there will be refunded to the original customer the sum of sixty ($60.00) dollars for each additional customer.

In this respect for the past two years the utilities have not requested the price of the line deposited in advance of construction, but have only required the difference between the refunds and the price of the line.

It is interesting to note that farm groups promoting their own lines endeavor to get the maximum refund allowance, consequently, the connection density factor on the lines built under this plan has averaged nearly 90 per cent.

Limitations to Refunding. No refunds for additional customers will be made after the close of the fifth calendar year following that year during which the extension was built. When the refunds for original and additional customers may reach a sum equal to one thousand ($1,000) dollars per mile of the extension all refunding will cease. No refunds for either original or additional customers will be made unless the extension is built by the company.

Taking on Additional Customers. When additional customers are connected to the extension the company will furnish and install transformer, meter and service wire to meter under same conditions as described for original customers.

Each Extension Separate. No refunds will be made to customers on an extension by reason of the fact that a later

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Presented before the Rural Electric Division of the American Society of Agricultural Engineers at Chicago, December 3, 1935.

Author: Farm service supervisor, Consumers Power Company. Mem. ASAE.

extension may be connected thereto. Each extension will be a separate, distinct unit for purposes of deposits refunding, etc. As compared to some of the existing policies this is important because it reduces bookkeeping and associated expenses and every economy practiced reduces the cost of farm service.

Rate for Electric Service. The rate for rural light and power service will be the company's standard residential lighting rate. This means that all energy is purchased through a single meter and gives the farmer the same rate as used in the city. A special off-peak water-heating rate on separate meter is now in effect at one cent per kilowatt-hour.

Transformer Capacities in Excess of 5 kva (Kilovolt-Amperes). All ordinary rural customers will receive adequate supply by the installation of transformer capacity of 5 kva for each customer. Whenever transformer capacity in excess of 5 kva is required for a customer such situations will be given separate consideration and the determination of the rate to be applied (which shall be one of the company's standard filed rates) and the nature and term of the contract will depend upon the conditions in each case. Few farmers really appreciate what this means unless they have experienced a transformer capacity charge.

Use of Extension for Other Purposes. In case a rural extension is constructed for use partly as a transmission line to serve an industrial customer, or a city, town or village where such other use does not justify the construction of the extension for such other uses alone, the additional cost of the extension may be charged against the original rural customers to be served from it. In no case, however, shall the amount charged against the original rural customers be greater than if the extension were made purely as a rural extension. Practically every village and hamlet in Michigan has electric service and the combination of farm and village service has affected a great economy for the farmer.

Extensions from High Voltage Lines. Rural extensions, as above described, refer to extensions made from transmission lines of 13,200 volts or less. Extensions made from transmission lines of over 13,200 volts shall be considered special and given separate consideration, and arrangements made depending upon costs and other conditions in each case.

Title to Rural Extensions. Title to all rural extensions, including rights-of-way, transformers, meters and service wire and poles between the pole and wire line and customers' meter shall be vested in the company.

Maintenance of Extensions. Company will maintain all property to which it holds title as described in above.

SERVICE FROM TRANSMISSION LINES

Where transmission lines, of 13,200 volts or less, have been built to serve some industrial customer, city, town, or village, and where the revenue from such business is adequate to justify the construction of the line, rural customers will be served from such lines upon application without contribution.

At the present time there are in excess of 10,000 miles of transmission lines in Michigan from which over 45,000 farms receive electric service. Approximately one-half of the total mileage is classified as rural lines and about 90 per cent of the existing rural lines were constructed under the "Michigan Plan."

This is significant when consideration is given to the extension policies in use by other Michigan utilities that include transformer capacity charges, service charges in accordance with the horsepower rating of motors and where an allowance against the cost of the line is based on the income from the extension over a period of two or three years.

To date the "Michigan Plan" has worked. It has functioned as it was designed to function, to permit as rapid a development as was consistent with any progressive development and to serve the more densely populated areas that should be served first.

However, with the lines extending further and further into less sparsely settled territory, the financial obligations of the farmer increase in proportion to the decreasing density factor and the time has arrived when a modification of the $1,000 a mile plan is necessary to keep the program going. It was with this in mind, as well as formulating plans of cooperative procedure with the federal Rural Electrification Administration, that the Michigan Public Utilities Commission called an open meeting in the state capitol on July 16, 1935. The meeting was called to hear the expression of opinions from farmers and others interested in rural electrification. As a result of the meeting a new state Rural Electrification Committee was established. It has eight members, one representing each of the following groups: The public utilities commission, the private utilities, the public utilities, the state department of agriculture, Michigan State College, the Farmers' Union, the state Grange, and the Farm Bureau.

A number of committee meetings were held during the summer, and on October 7 the Commission issued to the private utility operating in the largest agricultural area of the state an order that has been characterized by the Rural Electrification Administration as one of the most advanced orders regulating rural extensions yet promulgated in any state.

In substance the order recognizes some the simple basic truths: (a) an investment justifies a return; (b) regardless of who pays for a line it becomes a liability unless it delivers sufficient energy to pay its way; (c) the farmer should use his financial resources in purchasing energy-consuming appliances and equipment rather than in helping finance the line.

The order is to the effect that where there is an average of five customers to the mile the company builds the line without contribution from the farmer. The customers guarantee a minimum gross revenue of $150 per year which would be the equivalent of a $2.50 average of five per mile. The customer will receive on the present rate about 50 kilowatt-hours for $2.50.

Optional with this new plan is the plan I have discussed as the "Michigan Plan" of $1,000 per mile with refunds of $100 for original customers and $60 for additional customers.

How this new plan is going to work I do not know. The power company had thirty days to file the working mechanism of the plan with the Commission. I understand that the final wrinkles are now being ironed out.

The same order has been sent to every private utility in Michigan, not as a definite order but as a request that they conform in detail as near as their financial situation permits. Three utilities have already stated that they would adopt the plan.

Early in August a circular letter was sent to all county agricultural agents requesting that they instruct the farmers in their counties to conduct surveys of their respective communities in order to furnish a definite picture of their community to the state committee. The data requested was the same as requested by the REA, namely, the location of the community, miles of line necessary for service, the total number of customers and those agreeing to furnish free right-of-way and to take service as soon as a line was built, together with the uses of electricity in which they were interested. Copies of these surveys are being made in triplicate, one each for the REA, the state committee and the local utility.

Already the public utility commission has posted on what is called the master farm *(Continued on page 348)*

Application of Sulfuric Acid for Weed Control

By O. C. French

SULFURIC ACID has been used for many years in European countries to kill annual weeds in cereals. During the past five years its use has become very popular in France and England. The primary reason for delay in adopting this method of weed control in the United States has been the lack of satisfactory equipment for applying the acid.

Dilute sulfuric acid is applied as a spray on grain fields when the grain and weeds are in the early stages of growth. Best results have been obtained with grain from 6 to 8 inches in height. Various concentrations of acid can be used but in general 10 per cent, by weight, of 66-degree Baume commercial acid with water, applied at the rate of 130 gallons per acre, has given excellent results.

Annual weeds such as wild mustard and radish can be killed by this acid spray without permanent injury to the grain, because the weed has broad and rough leaf surfaces and exposed growing point, whereas the cereal plant has narrow and smooth leaf surface and enclosed growing point (Fig. 1). The destruction of the weed is caused simply by dehydration. After spraying, the ends of leaves of the grain plant become brown for a few days, but this soon disappears and because of lack of competition with the weed the grain becomes more vigorous than ever.

The results of tests, near Davis, California, on barley fields infested with wild mustard, showed that an average increased yield of 50 per cent was obtained by treating with a 10 per cent solution of acid. This increased yield is not considered exceptional because it has been duplicated in many parts of California. Much higher increases have been obtained when the fields were more severely infested with weeds.

EQUIPMENT DEVELOPED FOR APPLYING THE ACID

The objectives in developing a sprayer for sulfuric acid were three-fold: (1) to eliminate the necessity of handling concentrated acid and mixing it with water prior to spraying, (2) to eliminate the necessity of pumping the dilute acid, and (3) to make use of our present orchard type sprayers as the basis for the unit.

Handling of concentrated acid in the open always involves the danger of acid burns, also it is somewhat difficult to handle because it is heavy. Commercial 66-degree Baume acid has a specific gravity of 1.84, a gallon weighing 15.3 pounds. It is usually shipped in 50 or 100-gallon steel drums, the total weight when full being approximately 1700 pounds for a 100-gallon drum, and 900 pounds for a 50-gallon drum. Obviously, handling the acid drums is difficult unless some device is provided to hoist or roll drums into place.

For the reasons just mentioned it is desirable to handle acid as little as possible. Furthermore, considerable time is consumed in transferring acid from drums to sprayer tanks. If concentrated acid is mixed with water in open tanks, either the amount of acid has to be measured or the dilute mixture must be tested by the specific gravity method to determine when the proper amount of concentrated acid has been added.

Little need be said as to the reason it was desired to eliminate the necessity of pumping the dilute acid with the spray pump. It is hard enough to keep spray pumps operating properly without adding the factor of corrosion by acid.

The sprayer that was developed for experimental as well as demonstrational purposes was a portable power take-off orchard sprayer (Fig. 2). This unit was equipped with a 20-gallon-per-minute pump, a 400-gallon metal tank, and was mounted on dual pneumatic tires. On the rear of this sprayer a frame was built that held a 50-gallon drum of concentrated acid and also supported an 18-foot folding boom. A 3/8-inch Penberthy steam ejector was installed in the water discharge line from the pump, just ahead of the spray boom (Fig. 3). Water flowing through this ejector under 250 pounds pressure reduced the pressure in the suction side of the ejector sufficiently to draw concentrated acid from the drum. This method allowed the pump and tank to handle only water and no concentrated acid was handled except in the closed original container. All pipe

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers, at Estes Park, Colo., June 1936.

Author: Instructor in agricultural engineering, and junior agricultural engineer, Agricultural Experiment Station, University of California. Jun. Mem. ASAE.

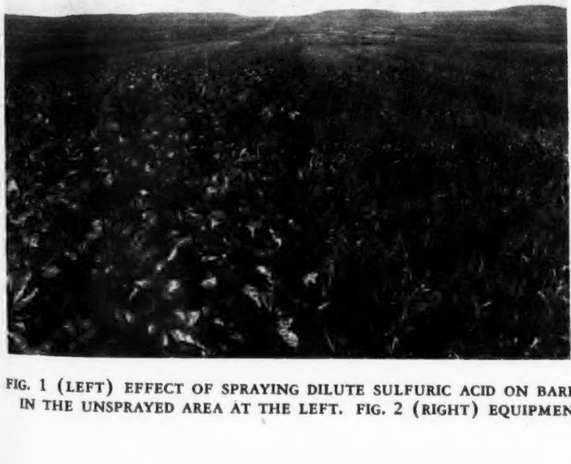


FIG. 1 (LEFT) EFFECT OF SPRAYING DILUTE SULFURIC ACID ON BARLEY FIELD HEAVILY INFESTED WITH WILD MUSTARD. NOTE MUSTARD IN THE UNSPRAYED AREA AT THE LEFT. FIG. 2 (RIGHT) EQUIPMENT FOR APPLYING DILUTE SULFURIC ACID SPRAY ON GRAIN FIELDS

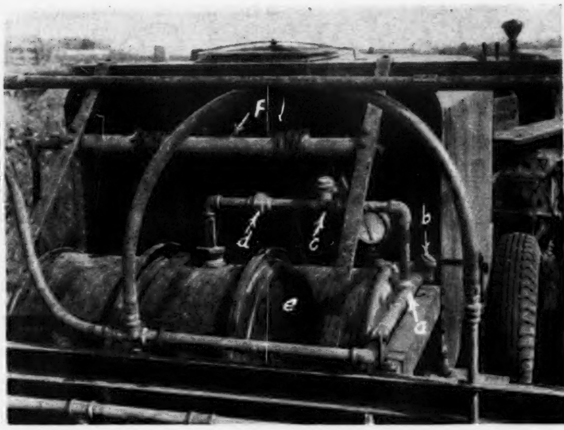


FIG. 3 (LEFT) VIEW OF PIPING SYSTEM FOR EJECTOR MIXING METHOD: (1) EJECTOR, (2) CUT-OFF VALVE ON WATER LINE FROM PUMP, (3) CUT-OFF VALVE ON CONCENTRATED ACID LINE FROM DRUM TO SUCTION SIDE OF EJECTOR, (4) UNION TO HOLD THIN PLATE DISK WITH ORIFICE TO CONTROL AMOUNT OF CONCENTRATED ACID FLOWING TO EJECTOR, (5) DRUM OF CONCENTRATED ACID, (6) WINCH TO LIFT DRUMS OF ACID INTO PLACE. FIG. 4 (RIGHT) SPRAY EQUIPMENT. NOTE ANGLING OF NOZZLES TO GIVE TWO COMPLETE COVERAGES

and pipe fittings coming in contact with acid were of everdur brass.

Nozzles were developed that gave a flat fan-shaped spray. These were placed on the boom 12 inches apart so that when the boom was about 24 inches from the ground the fans overlapped, thus giving a double coverage. Nozzles were alternately tilted so that the spray was directed both forward and backward (Fig. 4). The material for making the disks has given more trouble than anything else. The disks to be satisfactory under present methods of making them have to be soft enough to be drilled and formed and yet must resist abrasion by grit in water. As yet no metal has been obtained that is entirely satisfactory.

This year's field experiences have revealed a weakness in the boom construction recommended last year. On our experimental sprayer the boom was made of short lengths of pipe and fittings. Any threaded joint for handling acid is apparently a source of grief particularly when subjected to vibration. Our present recommendation is to make the boom out of a single piece of pipe. Drill and tap holes in the pipe where nozzles are to be located and screw a nipple, on which the nozzle is attached, into place; then braze it to the pipe. This will eliminate most of the trouble of leaks developing in the boom.

The practice of spraying grain fields is rapidly becoming a reality in California. This year seven sprayers were used and several thousand acres of grain were sprayed. The charge for contract work has been approximately $3.00 per acre for the total cost of application including acid, that is, for a 10 per cent solution of dilute acid applied at the rate of 125 to 135 gallons per acre. This cost is not unreasonable when you consider that many of the fields treated are producing 100 per cent greater yields of clean grain than could otherwise have been obtained.

Unit Heaters in Greenhouses

(Continued from page 336)

ments during the night and day periods. The two graphs come nearest each other during late December and early January which is to be expected in view of the relatively low heating effect of the sun at that time of year. The day temperatures are affected by the opening of doors and by ventilation. During the colder months, however, such factors are probably at a minimum. It can be shown by means of Fig. 5 that the average steam demand per unit of glass, per unit of time and per degree temperature difference between the inside and outside of the house for the daylight hours is only about 40 per cent of the demand at night for such greenhouses in the vicinity of the District of Columbia.

From actual measurements taken during the progress of this project, it has been possible to establish certain constants which may be of some value. One constant which is easy to remember is the following: 20 pounds of steam are required per 1000 square feet of glass or equivalent per degree-day in heating a greenhouse such as the one under test and located in those regions which have solar heating characteristics similar to those of the District of Columbia. Strictly speaking, perhaps this constant holds only for an average desired inside temperature of 65 degrees, but it is believed that the figure holds substantially well for other inside temperatures. Accordingly Table 2 has been devised. The fuel requirements are estimated from a basis of the steam requirements. The figures in Table 2 were obtained from tests of a house which was in good condition; more fuel would be required for leaky houses.

The efficiency of generation and transmission of the heating steam has been assumed at 60 per cent. The heat value of the coal has been assumed as 13,000 Btu per pound and the heat value of the oil as 148,000 Btu per gallon.

TABLE 2. STEAM AND EQUIVALENT FUEL REQUIRED TO MAINTAIN GREENHOUSE TEMPERATURES PER 1000 SQUARE FEET OF GLASS

(For the District of Columbia and vicinity)

Temperatures to be maintained in house, deg F	Steam required per season, lb	Coal required per season, tons	Oil required per season, gal
45	19,500	1.3	220
55	51,000	3.3	575
65	95,000	6.0	1,050

Vegetative Control in Soil Conservation

By Ernest Carnes

THE EROSION experiment stations and research departments of the state agricultural colleges have in recent years brought to our attention the importance of raising more close-growing crops on rolling hillsides, if such lands are to be saved for future generations. Farmers themselves are beginning to appreciate to some extent the necessity of adopting improved cropping practices if the topsoil is to be retained.

There are a few fundamental problems concerning the land itself that have not been generally understood by many farmers and agricultural workers. The slope of the land, the degree of erosion, and the soil type are fundamental factors that must be considered in planning a program for erosion control. Many of us in the past have planned the same type of crop rotation for a 10 or 12 per cent slope as we did for a 5 per cent slope. The Alabama Agricultural Experiment Station has shown conclusively in recent tests that as the slope increases so does the loss of soil under the same cropping conditions. It is further shown in these same tests that when the slope approaches 10 per cent, the rate of loss is greatly accelerated.

In order to bring to the attention of farmers, agronomists, engineers, and others these fundamental soil facts, soil specialists of the Soil Conservation Service have developed a plan of soil mapping which shows the slope, degree of erosion and soil type on each acre of land on a given farm, together with the present use of the land. Using this information as a basis, plans are made for a land use and soil conservation program on farms within demonstrational and camp areas.

I will not attempt to discuss at this time the entire field of vegetative control in erosion work, but I will endeavor to bring to your attention three or four phases of this work, which may be of general interest.

COMMON LESPEDEZA IN SOIL CONSERVATION AND LAND IMPROVEMENT

Since the organization of the Soil Conservation Service, and particularly during the last two years, annual varieties of lespedeza have been introduced as a field crop on a number of project areas in the Southeast. In a large portion of this territory, lespedeza can well be used in many of rotations, growing concurrently with grain in the rotation cycle. It is a splendid soil improvement crop, an effective erosion-resistant crop, produces good hay under certain conditions, and the farmer can save an adequate supply of seed in most cases.

Under a cooperative arrangement with the South Carolina Experiment Station, Dr. T. C. Peele, associate soil technologist, has been stationed on the South Tyger River Project area during the past year for the purpose of conducting certain phases of research work in connection with our program in soil conservation. While this work has been under way only about one year, several interesting things have been shown. Records have been kept on a number of runoff plots in this demonstration area in connection with different slopes and various cropping conditions. At Woodruff a series of plots on a Cecil sandy-clay soil has a 7 per cent slope. On July 3, 1935, 3.85 inches of rain fell. As a result of this one rain, the following soil loss and run-off were determined:

Plot No.	Crop	Runoff, gal	Per cent of runoff	Soil loss per acre, lb	Ratio
1	Bare	92,200	88	39,000	65
2	Cotton	65,400	62	31,400	52
3	Corn	50,400	48	17,400	29
4	Sudan grass	77,200	74	11,200	19
5	Lespedeza (2nd year)	15,800	15	800	1.1
6	Bermuda sod	6,800	6	600	1

This is not representative for Sudan, as the crop had not grown sufficiently at this time to give effective control. The Sudan grass was planted May 23 and had received less than 0.2 inch of rain prior to July 3.

In another series of plots, the relative amount of suspended soil material in runoff water from areas planted to cotton and lespedeza was determined. In this connection Dr. Peele made the following comment:

> "One of the subjects frequently referred to in discussions of soil erosion in this section is the amount of suspended soil material in the streams of rivers. Since this suspended matter comes largely from cultivated fields, it was thought that some measurements of the effects of crops, such as common lespedeza and cotton, on the concentration of suspended material at the terrace outlets, might yield some interesting results. These measurements were made in cooperation with the farmers in this area by catching running samples of water immediately after rains, while the water is still running out of the terrace outlets. Care was taken to avoid catching any of the bed load which would be greatly influenced by the velocity. Thirty-seven measurements were made from lespedeza terraces and forty from cotton terraces. The average of these measurements shows that there was a loss of 8.30 pounds of suspended soil per 1,000 gallons of runoff water from the terraces planted to cotton, and 2.50 pounds of soil per 1,000 gallons from the lespedeza terraces. Of course, a great deal less water ran off from the lespedeza terraces than from the cotton terraces."

Further studies were made relative to the amount of soil and water losses from areas planted to cotton and common lespedeza. One series of plats of 1/200 acre and one series of 1/100 acre were used in these measurements. While the degree of slope was different in each series of plats, the crops were compared on each series. The total amounts of soil and water loss as runoff from these plats were caught in large concrete or metal pits and carefully measured. The data represent a summary of information from 77 different observations following rains which occurred in three locations during the months of June, July, August, and September of 1935. The plats planted to cotton show an average runoff of 17.93 per cent, and those to lespedeza 10.76 per cent of the total rainfall. The soil loss from areas planted to cotton was 17.87 tons, as compared to 1.18 tons per acre for areas planted to lespedeza. More than fifteen times as much soil was lost from the cotton plats as from the lespedeza plats.

Some interesting studies were also made during the past year concerning the yield of cotton following lespedeza as compared to cotton following cotton. These studies were made possible because of the strip-cropping work done in the South Tyger River area during 1934. Thirty-three plots showing comparative yields were studied. The comparisons in each case were uniform as to tillage, fertilizer, treatment, and soil type. Cotton yields were obtained by boll count.

Presented at a meeting of the Southern Section of the American Society of Agricultural Engineers at Jackson, Miss., February 1936.

Author: State coordinator for South Carolina, Soil Conservation Service, U. S. Department of Agriculture.

The average yield of seed cotton following lespedeza was 939 pounds per acre, as compared to a yield of 583 pounds per acre of seed cotton following cotton, which shows an average increase of 358 pounds, or 61 per cent, in favor of lespedeza. In every instance larger bolls were secured from the cotton following lespedeza. The soil types were Cecil clay loam and Cecil sandy loam. Reaction of farmers as to the use of common lespedeza for soil improvement was obtained, and, without exception, they stated that where lespedeza was plowed under it had materially increased the growth and yield of cotton and corn.

As a result of our work with lespedeza in this particular project area, most of our farmers are now growing this crop and harvesting their own seed.

One of the most difficult problems in the soil conservation program is to discharge water from terrace outlets to permanent stream channels without the development of gullies. Much progress has been made in the past two years toward perfecting better types of check dams in terrace outlet channels; yet, most of these structures are expensive and beyond the reach of the average farmer. On the Spartanburg project, we have a number of meadow strips which are functioning very well as terrace outlet channels. These are located in natural draws or depressions which have been prepared as seed beds and sodded to such crops as alfalfa, sericea, lespedeza, etc. These strips vary from 40 to 60 feet in width.

Some of the advantages of meadow strips, as terrace outlet channels, are:

1 The average farmer can construct and maintain this type of outlet.

2 The land in such strips can be used to produce worthwhile crops. One meadow strip in the Spartanburg area during the past summer produced 2¼ tons of good hay on 1.2 acres.

3 Such outlets can be crossed easily with farm machinery, thereby facilitating improved agricultural practices.

4 The average cost of construction is estimated to be approximately one-third the cost of masonry structures.

Some of the difficulties to be encountered in the use of meadow-strip outlets are:

1 Natural depressions or draws are not always present where terrace outlet channels are needed.

2 In order to be most effective meadow strips should not be used as terrace outlet channels until the sod is well established.

3 It is questionable whether such strips can be used on slopes greater than 8 or 9 per cent, unless Bermuda or similar plants are used.

4 Good topsoil is necessary for growing a good sod for effective results. This condition does not usually exist where terrace outlet channels are to be constructed.

5 Where a large quantity of head water is present, more difficulty will be encountered in the establishment of meadow strips.

It is estimated that it would require one hundred tractor units twenty years to properly construct all the farm terraces needed in the Piedmont section of South Carolina. While terracing is only one of the control measures in a coordinated soil conservation program, it will always be an important part of the program because such a large acreage of our land is annually planted to clean-tilled crops. In the face of these facts, we believe it will be necessary in the future for the farmers to complete at least part of this terracing work with horse-drawn equipment. The farmer can do this job on areas that are not too steep or too badly eroded, leaving the more difficult tasks of construction for the power units. It is true that farmers throughout the South have been building so-called terraces with horse-drawn equipment for a number of years. We believe that farmers will be able to construct reasonably good terraces with equipment already available on the farms, provided that the cropping system is planned so that the maximum amount of vegetation will cover such fields during the early construction period. In order not to disturb the usual crop rotation of cotton, grain and corn, this system of terrace construction should be started in the fall when grain is to be planted. More than fifty such demonstrations are now being conducted in project and camp areas in South Carolina under the supervision of the soil conservation associations.

The following plan is being put into effect in connection with this work which was started in October and November 1935:

1 The water disposal system was planned, the terrace lines surveyed, the terrace ridges plowed, and the entire field sowed to grain, either oats, barley, or wheat.

2 In February or March of 1936, lespedeza will be sown between the terrace ridges, on the grain, but not on the ridges.

3 The grain will be harvested in the spring of 1936, and the ridges plowed the second time. This will not disturb the lespedeza. The terrace ridges will be sown to sorghum or Sudan grass to be harvested as a hay crop.

4 In the fall of 1936, the hay crop will be harvested from the ridges and the third plowing will be done. The ridges may be sown to a winter cover crop of grain, vetch, or Austrian winter peas. The lespedeza may be harvested for hay or seed and the stubble left for winter protection.

5 In April or May 1937, the fourth plowing will be done, turning under the cover crop, and then sowing a summer hay crop. The area between the terrace ridges (lespedeza sod) will be plowed under and planted to corn, and interplanted with soybeans or cowpeas.

6 During the fall of 1937, the hay crop from the "ridges" will be harvested and the terrace ridges will be plowed the fifth time.

7 In the spring of 1938, the sixth plowing of the "ridges" will take place, after which the entire field, including the terrace ridges, will be prepared and planted to cotton, the third and last year of the rotation cycle.

This method of terrace construction offers a number of advantages, including

1 No initial cash expenditure.

2 With the exception of the "panning-up" of the low places, no extra labor is required, as the land must be plowed any way.

3 The maximum vegetation is had at the time when the terraces are least efficient.

4 The rotation system is not disturbed provided the terracing is started concurrently with the grain in the rotation cycle.

5 A sod is turned under at each plowing, which will result in more efficient terrace construction.

A Correction

ATTENTION is called by the authors of the article, entitled "Self-Aligning Disk Jointer," appearing on page 304 of AGRICULTURAL ENGINEERING for July 1936, to a somewhat misleading statement that was inadvertantly made and which appears in the second sentence of the article; it gives the impression that the draft test related only to plow attachments, whereas both the plow and the attachment were included. The statement should have read as follows:

"The accompanying chart summarizes the results of five series of draft tests and shows total draft of plow, per 14x7-inch furrow, when using different attachments. The total plow draft averaged 14.2 per cent less when using the self-aligning disk jointer than when using regular colters and jointers."

A Telescoping Wagon Tongue

By C. K. Shedd and E. V. Collins

A TELESCOPING wagon tongue was developed as a result of work on corn production machinery research at Ames, Iowa, under a cooperative agreement between the agricultural engineering section, Iowa Agricultural Experiment Station and the Bureau of Agricultural Engineering, U. S. Department of Agriculture.

In the fall of 1931, time studies were made of the operation of several makes of corn picker-huskers using the wagon tongues and hitches that were regular equipment with these machines. In time studies of a two-row mounted type picker the average time required for each wagon change was 1 minute 42 seconds and the total time the machine was stopped to change wagons was 12.8 per cent of the net operating time. The outfit was designed for one-man operation, except that two men were required to change wagons. Inconvenience and loss of time in using the regular hitch equipment prompted the writers to design the telescoping wagon tongue.

In a similar test of the same machine as above in 1933 using wagons with telescoping tongues, the wagon changing was all done by the picker operator without assistance. The average time required for each wagon change was reduced to 41 seconds and the total time to change wagons was reduced to 4.5 per cent of the net operating time.

With a two-row mounted type of picker the regular hitch provides for attaching the wagon tongue to the tractor drawbar directly behind the center of the tractor. A short tongue on the wagon is necessary in order to place the wagon in the correct position to receive the corn from the picker elevator. The usual procedure in coupling is for the operator to back the tractor up to the correct position while a second man holds the tongue and makes the coupling.

The loaded wagons may be hauled to storage either by team or by trailing behind a tractor or a truck. If hauled by team, a tongue extension must be attached to make the tongue long enough for a horse hitch. The regular hitch includes a tongue extension that is convenient to attach. If the loaded wagon is trailed to storage by tractor or truck, the stub tongue may be used without change but two men are needed to make the coupling.

Notice may be taken that some tractors are made with a low-down operator's platform and with a hand clutch lever which may be reached by a man standing on the ground to the rear of the tractor. With such a tractor it is possible for the operator to couple to a wagon without assistance by holding the wagon tongue with one hand, while he uses the other hand on the clutch lever to control the movement of the tractor. It is hardly necessary to point out that this is a dangerous procedure. Even when the tractor operator has a helper to make the coupling, they should work with extra care. The man making the coupling is always in some danger of bodily injury.

The telescoping tongue, when extended to full length and locked in this position, is a wagon tongue of standard length suitable for horse hitch. When not locked in the extended position, it may be shortened to about 4½ feet by telescoping. It is then a stub tongue suitable for trailing the wagon behind a tractor, a truck, or another wagon. Fig. 1 shows the tongue in extended position, and Fig. 2 shows it in short position. The drawings, Fig. 3, show details of construction.

With the telescoping tongue, the tractor operator can readily couple the wagon to the tractor without assistance and there is no risk of bodily injury in making the coupling. To make the coupling with this equipment, he stops the tractor in position such that the tractor drawbar is anywhere within 4½ feet of the end of the wagon tongue, the tongue being in short position. He then gets off of the

Journal Paper No. 7-345, Iowa Agricultural Experiment Station, Project No. 393. First publication in AGRICULTURAL ENGINEERING.

Authors: Respectively, agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture (Mem. ASAE), and research professor of agricultural engineering, Iowa Agricultural Experiment Station (Mem. ASAE).

NOTE: The telescoping wagon tongue embodies some elements old in the art to which they relate. As to these features, they are of course public property and may be used freely. The tongue described herewith also embodies some novel features which are thought to be original, and it is the purpose of this paper to make such features available for free public use. It may be, however, that some features or improvements thereon are embodied in this design that are covered by existing patents, and therefore it must be understood that the authors, the Iowa Agricultural Experiment Station, or the USDA do not assume any responsibility in connection with any claim of infringement that may be made against the apparatus shown.

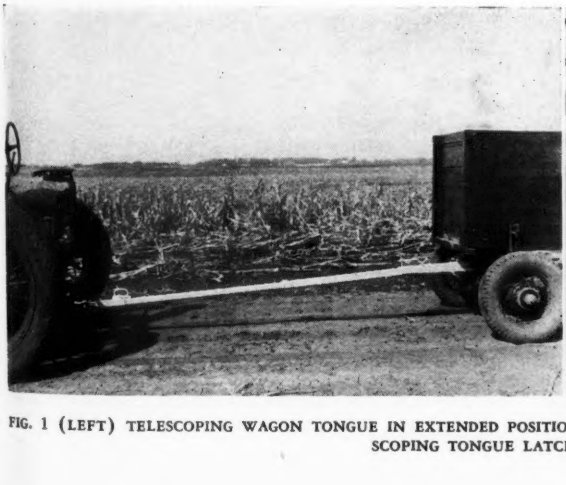


FIG. 1 (LEFT) TELESCOPING WAGON TONGUE IN EXTENDED POSITION, THE RIGHT LENGTH FOR A TEAM HITCH. FIG. 2 (RIGHT) TELESCOPING TONGUE LATCHED IN SHORT POSITION

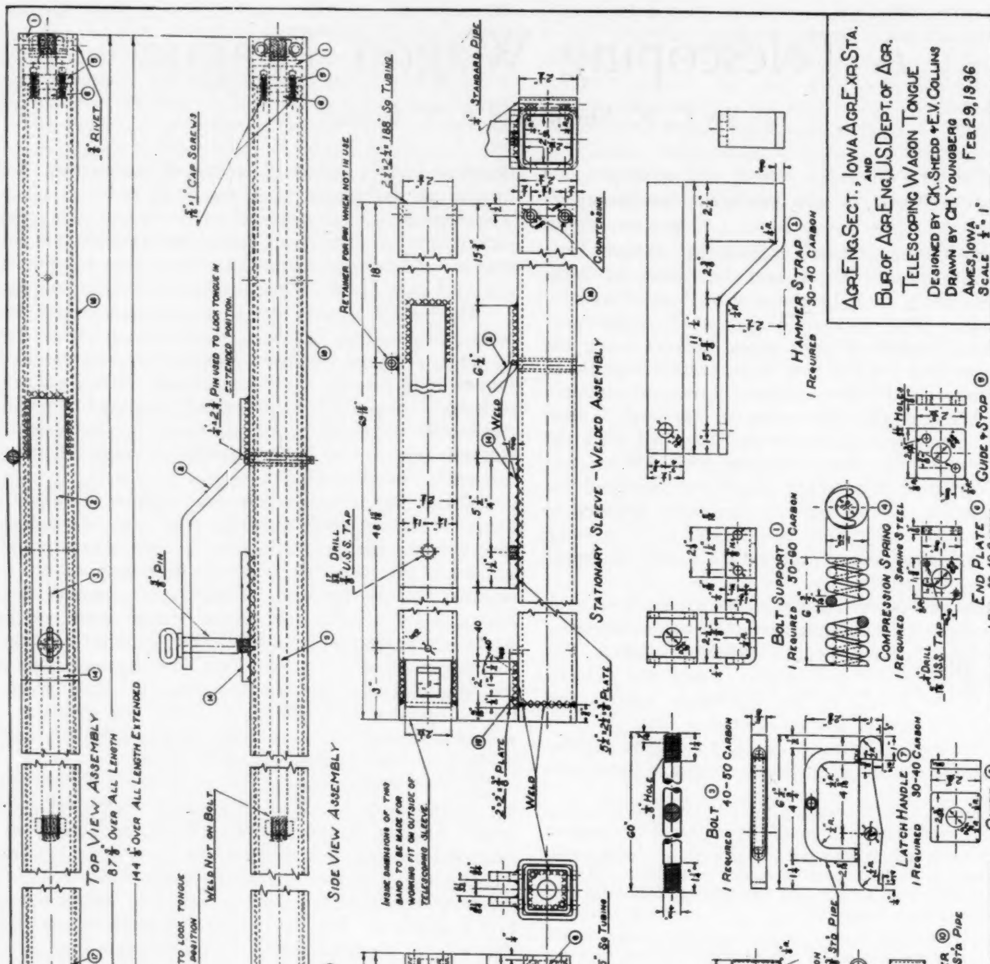


FIG. 3 CONSTRUCTION DETAILS OF THE TELESCOPING WAGON TONGUE FOR TEAM, TRACTOR, OR TRUCK HITCH

tractor, unlatches the tongue, pulls it out to the right length to reach the tractor drawbar and makes the coupling. He then gets on the tractor and backs up until the tongue latches in its short position.

In a similar manner, one man can easily couple two or more wagons in a train as shown in Fig. 4. For this purpose, each wagon should have a telescoping tongue, also a drawbar at the rear.

The use of telescoping wagon tongues is advantageous in the following situations:

1 When wagons are being trailed short distances with a tractor or truck and frequent coupling and uncoupling is necessary; as, for example, in harvesting corn with a machine picker when the loaded wagons are pulled to the storage building and the empty wagons returned to the field with a tractor or truck.

2 When it is necessary to pull the wagon part of the time by team and part of the time by tractor or truck. An example is when husking corn by machine and hauling the loaded wagons to storage by team. Another example is in harvesting any crop when it is desired to pull loaded wagons out of the field to the highway by team, then trail them by truck to destination.

3 When it is desired to couple two or more wagons in a train. For example, one man without assistance may harvest corn with a mounted picker by trailing two or three wagons in a train to the field with the tractor, operating the picker until the wagons are all filled, then trailing the loaded wagons in a train to the storage building.

FIG. 4 TRAIN OF WAGONS EACH EQUIPPED WITH DRAWBAR AND TELESCOPING TONGUE. THE OPERATOR CAN EASILY COUPLE UP THE TRAIN WITHOUT ASSISTANCE

4 In any situation when it is desirable for the tractor operator to couple up to a loaded wagon without assistance. Even when a helper is available to make the coupling the danger of injury is reduced by using a telescoping tongue.

The telescoping tongue will necessarily cost more than an ordinary wagon tongue, but the additional convenience and safety and the additional work accomplished with a corn picker due to time saved in coupling wagons will, under suitable conditions, justify an additional investment in telescoping tongues.

A Power Line Construction Exhibit

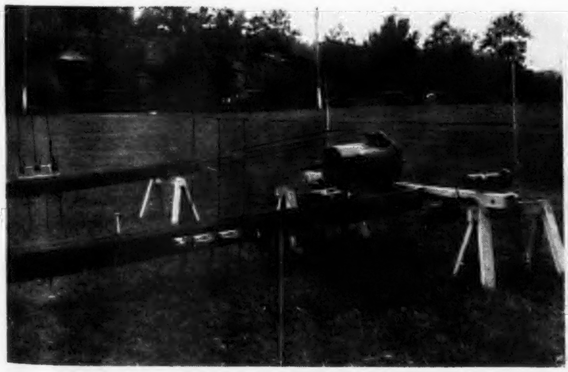
By John R. Haswell

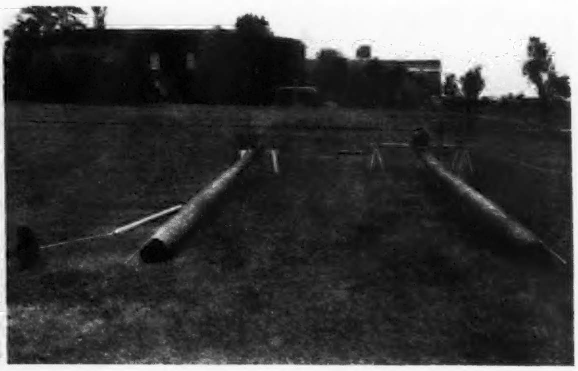
THE accompanying two photographs of part of our Farmers' Day exhibit show standard rural line extensions in Pennsylvania. Of course, some companies have slightly different hook-ups than the type shown, but as far as I know all of them give 3-wire service which is intended for 230-115 volts.

Much of our difficulty, in holding agricultural extension meetings with the county agents, is to make the farmers realize that it costs considerably more to build electric power lines than it does the telephone systems costing $300 or $400 per mile. It would seem that these pictures would help answer such questions.

The pole with the transformer on it has on the cross arms No. 2 stranded steel and aluminum cable, which carries 2300 to 4600 volts. The three wires on the low side of the transformer are No. 4 weather-proof copper. The upper, or right-hand one in Fig. 1, is a grounded neutral which is connected to the ground wire as shown under the wooden molding. This ground wire also leads from the underside of the lightning arresters on the ends of the cross arm. The lower end of the ground wire is clamped to a driven ground which extends below the bottom of the pole as shown in Fig. 2. The ground line, as indicated on the poles, does not show in the photographs. Fuse plugs are shown on the cross arm between the lightning arresters and the transformer (Fig. 1). Just above the bracket on the transformer pole is another lightning arrester for the secondary neutral. The pole without transformer is intended to take current into the farm from the three wires on the transformer pole. It is shown with a guy cable and anchor.

Author: Professor of agricultural engineering extension, division of agricultural extension, Pennsylvania State College. Mem. ASAE.





A FARMERS' DAY EXHIBIT AT PENNSYLVANIA STATE COLLEGE, SHOWING GOOD RURAL POWER LINE CONSTRUCTION AND WHY IT COSTS MORE THAN TELEPHONE POLE LINES. FIG. 1 (LEFT) LINE, TRANSFORMER, FUSE BOX, LIGHTNING ARRESTER AND GROUND CONNECTIONS. FIG. 2 (RIGHT) GUY WIRE ANCHOR AND POLE GROUNDS

Engineering Phases of Pink Bollworm Control

By D. A. Isler

THE PINK BOLLWORM is a major cotton insect pest now found in all cotton-producing countries of the world. In areas where the pest has become firmly established damage to the crop is estimated at from 10 to 50 per cent. This loss in yield and quality of both cotton seed and lint is caused by the larvae which feed on the lint and the seed kernels within the bolls.

The pest was first discovered in the United States at Hearne, Texas, in 1917. This infestation, as well as others in eastern Texas, western Louisiana, the Salt River Valley of Arizona, and isolated sections of western Texas have been eradicated due to persistent and thorough efforts of federal and state officials. Except for a light infestation in Florida and southern Georgia, where an eradication program is in progress, present known infestation in this country is limited to irrigated sections near the Mexican border where infestation has persisted despite various repressive measures.

Other than the usual regulation of movement of material suspected of harboring a dangerous pest, present eradication and control measures are accomplished by two general methods of procedure: The destruction of worms in marketable cotton products or those which are removed from the farm; and field clean-up campaigns followed by non-cotton zones or other restrictions as to planting.

Engineering phases of the methods employed for safeguarding marketable cotton products involve measures for the treatment of cotton seed, lint cotton or baled cotton products, and destruction of worms in the waste and trash which accumulates around gins and oil mills. All regulatory measures are enforced by both state and federal agricultural authorities.

In the infested areas sterilization of all cotton seed as a continuous process of ginning is required. Sterilizers for this purpose consist of specially constructed steam heating boxes and operate either on the live steam or dry heat process. The seed are exposed to a minimum temperature of 145 degrees (Fahrenheit) for 30 seconds or longer depending upon the type of sterilizer used. Germination of the seed is not impaired unless the temperature is allowed to exceed 160 degrees.

There are several methods of safeguarding the ginned cotton lint, and the regulatory measures required vary with the intensity of infestation in the particular district concerned. The oldest method, and the one still used for disinfecting foreign products at ports of entry, involves vacuum fumigation of the compressed bales with hydrocyanic acid gas. Sterilization of the bales with live steam at a pressure of 20 pounds for 3 minutes in a specially constructed steam sterilizer was practiced for the past several years in some of the regulated districts of Texas. For treatment of domestic cotton, this, as well as the compression and vacuum fumigation method, have been replaced to considerable extent by the use of a set of smooth crushing rolls through which the lint cotton must pass just before it drops into the bale press box during the ginning process. Maintenance of ample spring tension on the rolls insures the crushing of any worms in the lint cotton.

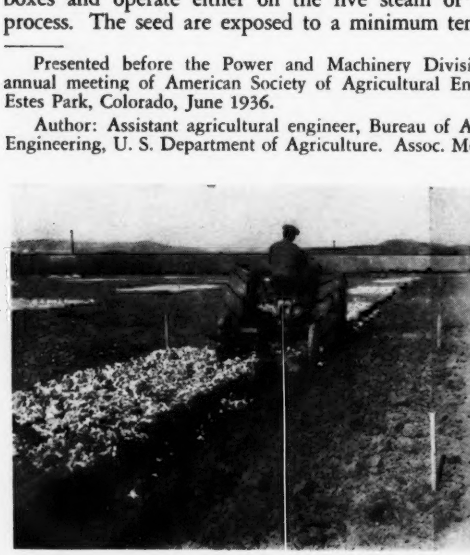
Pink bollworms in the trash which accumulates around gins and oil mills may be destroyed by burning, steam sterilization or milling. Burning is the surest, simplest, and most economical method to use. This requires an incinerator so located as to reduce the fire hazard to adjacent property to a minimum. Sterilization by steam renders the trash free from living pink bollworms. In repeated tests with gin trash heavily infested with pink bollworms, it has been shown that passing the material through a hammer type feed mill will destroy the worms and make the material safe for feeding purposes. Regulations regarding gin trash disposal vary somewhat in the various regulated districts.

Although the cotton products which are removed from the farm are properly safeguarded by the foregoing regulatory measures, there are large numbers of worms left in that part of the crop which remains in the field.

Because of the continually increasing degree of infestation in the Big Bend area of western Texas and the potential menace of the pink bollworm to the main cotton belt, a research laboratory was established on the Mexican border at Presidio, in 1928. The field control investigations at this

Presented before the Power and Machinery Division at the annual meeting of American Society of Agricultural Engineers, at Estes Park, Colorado, June 1936.

Author: Assistant agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Assoc. Mem. ASAE.



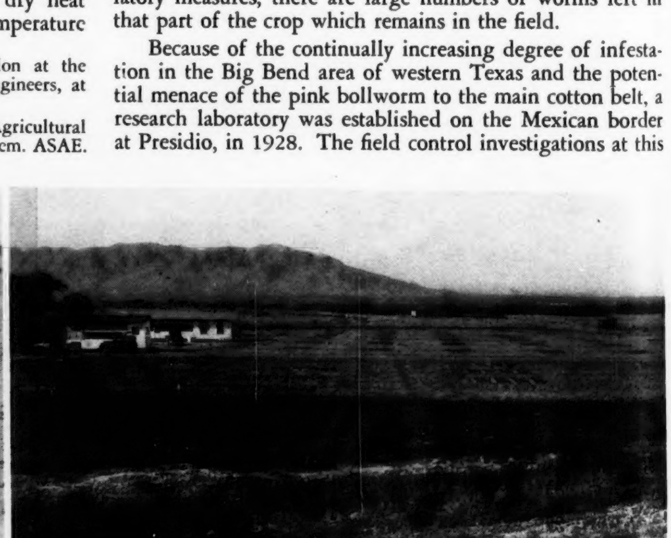


FIG. 1 (LEFT) PLOWING UNDER THE LAYER OF INFESTED COTTON BOLLS IN THE CULTURAL CONTROL TEST PLOTS. FIG. 2 (RIGHT) MOTH EMERGENCE CAGES ON THE SMALL SCALE PLOWING AND IRRIGATION TEST PLOTS

laboratory have been carried out by the Bureau of Entomology and Plant Quarantine and the Bureau of Agricultural Engineering of the U. S. Department of Agriculture in cooperation with the Texas Agricultural Experiment Station. The agricultural engineering work has involved three general classes of investigation. One for the development of mechanical equipment for cleaning the crop remnants from the fields, one for a study of the effectiveness of plowing and irrigation in reducing the pink bollworm population and another for the development of equipment for more efficient application of insecticides.

As the insect spends the winter in the fields in the larval or worm stage, this, so far, appears to be the most vulnerable point of attack. The worms are found in the unpicked and immature cotton bolls, in the surface trash, and in the soil. The fact that the worm feeds inside the squares and bolls makes the discovery of practical control measures which can be applied during growth of the crop a difficult task. It would appear, therefore, that control by destruction of the worms in the crop remnants, surface trash, and in the soil is most logical.

In field clean-up campaigns, the cutting, piling, and burning of the stalks, and collections of the surface trash has been accomplished principally by hand labor due to lack of suitable machinery for the purpose. Mowing machines, cotton stalk cutters, and horse-drawn stalk shavers are not efficient due to the rank growth of plants prevalent in irrigated valleys and the excessive shattering of infested bolls from the plants during the cutting process. The Bureau of Agricultural Engineering has developed a push-type shaver for cutting the stalks at ground surface. This apparatus, in principle, is similar to a sled-type shaver, except that it is attached to the front of a tractor and is pushed along the ground between two rows of plants. The cut stalks are guided out in windrows to either side of the tractor by shields which prevent the stalks from being passed over by the tractor wheels. This shaver cuts the stalks with a minimum of shattering and being held rigidly in place the heavier stalks do not pass uncut around the ends of the cutting blades.

Collection of the cut stalks into piles for burning cannot be satisfactorily done by ordinary dump or side delivery hay rakes due to the rank plant growth and high irrigation borders. The Bureau of Agricultural Engineering has developed a push rake utilizing the same method of attachment to the tractor as is used for the shaver, which promises to be a practical and efficient rake after further slight alterations. Large readily burnable piles may be collected by the rake. Efficiency of both the shaver and rake would be considerably increased by use of low-pressure pneumatic tires on the tractor rather than the lugged steel wheels which tend to bury plant forms in loose sandy soils.

Collection of the bolls which shatter off the plants and other fine leaf particles and surface trash presents quite a difficult and perplexing problem. In the past this material has been collected by hand raking and hand picking which is the largest item in the cost of the field cleanup work. At present an attempt is being made to develop a suction field cleaning device for gathering the debris. Preliminary tests of a small field burner developed at the Toledo shops of the Bureau of Agricultural Engineering for orchard burning work showed that the apparatus was a very effective control weapon for destruction of this surface trash but that the cost of operation so far appeared to be rather excessive. Further investigations may result in a considerable increase in efficiency of the burner.

The various methods discussed so far are aimed at control or destruction of worms in all material above the soil surface. Field population studies conducted by the Bureau of Entomology and Plant Quarantine show that large numbers of worms spend the winter in the soil. Successful control of the European corn borer by clean plowing prompted a study of cultural operations for pink bollworm control. At Presidio, Texas, during the past several years, a series of experiments have been conducted to determine the killing effect of burial by use of various kinds of plows in different types of soil at different dates and depths of plowing, both with and without irrigation. These tests were conducted on a small plot basis and effectiveness of the various treatments was determined by the number of moths which emerged and were trapped in cages set over the soil of the treated plots. The outstanding result of the four-year tests was that most effective control resulted when plowing with complete coverage was followed by an irrigation as soon as possible, or within one week after plowing. At Presidio, plowing prior to February 1 was found to be bad practice when the application of an irrigation was delayed until just previous to planting time. No experiments have been conducted outside irrigated areas, but there is a strong probability that the winter rainfall and lower temperatures of the main cotton belt would increase effectiveness of winter plowing. Increases in depth of plowing resulted in decreases in survival. In general, superior coverage and more effective control were obtained with 14-inch plows than with either 10 or 12-inch plows, or disk plows.

Some of the most promising treatments discovered in the small plot tests mentioned above were also tested on a field basis in which an entire farm was given a specified

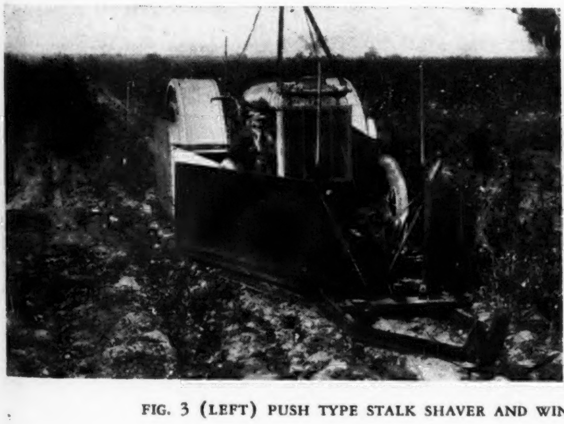
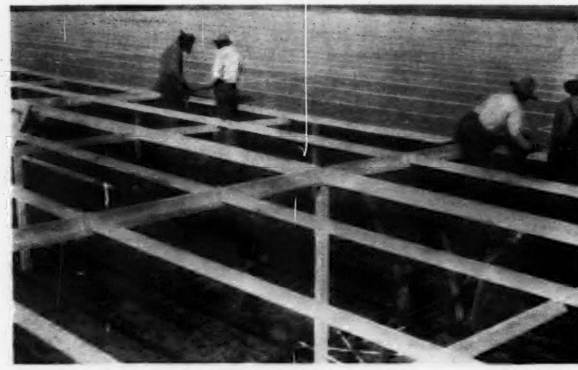


FIG. 3 (LEFT) PUSH TYPE STALK SHAVER AND WINDROWER. FIG. 4 (RIGHT) EXPERIMENTAL PUSH RAKE



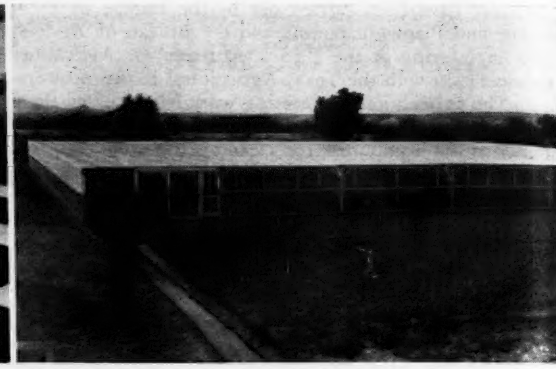


FIG. 5 (LEFT) CONSTRUCTION OF SCREENED CAGE FOR FIELD SCALE CULTURAL CONTROL TEST WORK. FIG. 6 (RIGHT) TWO-COMPARTMENT, 0.56-ACRE, SCREEN-WIRE-COVERED CAGE FOR FIELD CONTROL TESTS. (ANOTHER COMPARTMENT IS BEING ADDED)

control treatment. Results were based on the degree of pink bollworm infestation in the crop following treatment. An influx of pink bollworm moths from adjacent untreated areas was believed responsible for failure of these field scale tests to show positive control. This moth migration factor is substantiated by records of the Bureau of Entomology and Plant Quarantine which show that in fields which had not been planted to cotton for several years a damaging worm infestation was recorded in the first crop of cotton to follow the idle period.

In order to prevent this migration of pink bollworm moths, a three compartment screen wire-covered cage, 8 feet in height and covering an area of approximately 0.77 acre is under construction. This cage will prevent moth migration from nearby untreated fields, and it should then be possible to prove or disprove the value of cultural treatments.

In connection with field clean-up measures discussed in preceding paragraphs, discovery of effective cultural control treatment would eliminate the necessity for efficient surface cleaning. At the same time a very high mortality of worms beneath the soil surface would result with little additional expense other than the proper timing of efficient plowing and irrigation.

Preliminary studies are being made of the use of insecticides for control during growth of the crop. Considerable dusting machinery improvement appears necessary before this method of control is proved practical. The eggs are laid in protected places on the plant and the young larvae do very little feeding before they enter the bolls. To be effective, therefore, a poison should be well distributed over all parts of the plant, and the bolls in particular. A limited amount of work has been done to improve the dust distribution of present commercial dusting machines by providing efficient placement of more dust outlets per row.

No pink bollworm survival was recorded in limited experiments following the use of calcium cyanide or paradichlorobenzine when applied in the open furrow while plowing under infested cotton bolls. The rate at which these chemicals were applied in the tests, however, was too excessive to be practical.

In summarizing the engineering phases of present investigations for discovery of effective field control of the pink bollworm consist of the following:

1 Development of mechanical equipment for the destruction of worms in the crop remnants.

2 Determining the value of plowing, irrigation, and other cultural practices as control measures.

The agricultural engineer has opportunity to play a very important part in perfecting methods for the control of the pink bollworm.

Line Extension Policies

(Continued from page 338)

electrification map over 1500 miles of line in an area served by one private utility where the density factor ranges from five to thirteen customers per mile. By January I predict that over 3,000 miles of line will be located on the state map where immediate construction by our utilities will not only be feasible but will fall in the category of mandatory construction. This means that Michigan is about ready to launch approximately a $10,000,000 program in rural electrification, including wiring and equipment to be completed within the next twelve to eighteen months.

So far I have dealt only with private utility development without consideration of the extensions that will be built by REA. As previously stated, it is the objective of the state committee to cooperate to the fullest extent with REA. In so doing we believe that the first step is to get the best possible proposition from our own utilities, which should be equally as good as, or preferably better than, any other. This permits us to offer two methods of receiving service to our farmers, they of course to be the final judges. We already have a number of REA surveys being conducted and two large projects ready to submit for REA approval.

In conclusion, I would state that very definite progress has been made under the "Michigan Plan" of line extensions. This plan is still effective and optional to the customers, together with the REA program and our so-called "new plan." Never in history has the farmer had the opportunity of receiving electricity that he has today.

Back Issues of AGRICULTURAL ENGINEERING Wanted

AGRICULTURAL ENGINEERING has an urgent request from a member of the American Society of Agricultural Engineers, which it is unable to fill, for copies of its issues for September, October, November, and December 1920, and January 1922. The person desiring these copies offers 40 cents per copy. Anyone having and desiring to dispose of copies of any of these issues please communicate with the editor, or with H. B. White, Division of Agricultural Engineering, Department of Agriculture, University of Minnesota, St. Paul, Minn.

Water Supplies on Farms for Fire Department Use

By Harry E. Roethe

FARM FIRE protection in its broadest aspect embraces fire-protective construction of buildings, elimination of fire hazards, use of first-aid equipment for combating fire in its incipient stage, and utilization of motorized fire apparatus.

A large number of farming areas are now being served by rural (community) fire departments. Assuming that the fire-fighting apparatus is efficient and that the department is properly organized, trained and maintained, its effectiveness in reducing fire losses on farms will depend upon a number of factors, among which might be mentioned promptness in transmitting and receiving the alarm, condition of roads, distance to be traveled, water supply on the farm for fire department use, and location of farm buildings with respect to their proximity to one another.

The Farm Fire Protection Committee of the National Fire Protection Association has prepared a report, entitled "Rural Fire Departments, Equipment, and Organization," which is intended to serve as a guide to rural communities desiring to purchase efficient fire-fighting apparatus, and to outline certain minimum requirements relating to the operation and maintenance of the equipment. It is recognized that local conditions vary with respect to purchasing power of the communities, available water supplies, and areas to be served. Consequently in this report an attempt has been made to outline the types of apparatus which appear to be most suitable for these different conditions.

Efficient motorized fire apparatus carrying either chemical tanks or water tanks, or both, can cope only with fires of limited extent on farms, unless provision is made for an additional supply of water. Adequate water supply on farms served by motorized fire apparatus is therefore of major importance, and it is this subject which I wish to stress in this paper. Furthermore, this is one of several problems or subjects which directly concerns the agricultural engineer.

The Farm Fire Protection Committee of the NFPA has also prepared a report, entitled "Water Systems for Fire Protection on Farms," which suggests ways and means for the most efficient utilization of available water supplies in extinguishing farm fires and presents certain essential features which should be provided to give reasonably adequate fire protection when new water systems are contemplated. The following material on water supplies for fire department use is taken from this report:

"Where a stream or pond with dependable supply is within a few hundred feet of farm buildings, the problem of additional supply is simple; it is only necessary to furnish easy access to the supply for the fire department pumper. This may mean constructing a roadway to a spot of firm ground from which the pumper may operate or, possibly, filling in to provide such a landing stage. The pond may need to be deepened or the stream dammed to make a pool from which suction may be taken. Such ponds or streams may be made attractive, and are also often of practical value in furnishing additional water supplies for stock or for other productive purposes.

"In other instances it may prove better to dig a small canal to a suitable point for operation of the pumper, or to extend a tight pipe line to the farm with a hydrant in the yard from which the pumper may take suction. Fire engines usually carry at least 20 feet of suction hose, but under average conditions a pumper cannot be expected to lift water more than 15 feet. Consultation with the fire department officials will be valuable in deciding the exact layout which should be provided.

"Where no natural supply is available, additional storage of water should be provided for fire department use. This is best provided in an underground tank, although elevated tanks which are part of the domestic water system may be used if of sufficient capacity and if a suitable hydrant or other connection is provided for the pumper. Rural fire departments commonly use a ½-inch nozzle which requires about 50 gallons of water a minute for an effective stream. Sufficient water supply for at least one hour's pumping should be available.

"It is best to make the full capacity of the tank or reservoir 4,000 gallons to allow for the tank not being full at all times. Such capacity will require a tank 8x8x8.5 feet. Tanks may be purchased ready to install or built in place by farm labor. Various materials may be used according to their availability. Whatever materials are used should be permanent and suitable for underground use. The tank should be centrally located and have suitable manhole opening for access by the fire department for suction purposes. Regular inspections to insure full storage should be made. Where storage is also to be used to supplement an adequate supply for the farm water system, the capacity should be increased to 5,000 gallons, since part of the first aid supply will be used up before the fire department arrives. Where the tank is to be used in connection with house piping lines, provision should be made for regular flushing, cleaning, and other sanitary safeguards."

Indicative of what can be accomplished in rural fire protection is the work recently done in Massachusetts on the construction of "water holes" for providing a supply of water to be used by fire department pumpers in communities not having water systems. In this state project CWA funds were allotted, practically all for labor costs, for the construction of numerous "water holes," involving some 500 sites in the rural or outlying sections of towns in southeastern Massachusetts. In selecting the sites consideration was given to the amount of property which might be protected within 1,000 or 1,200 feet of the location. The quantity of water stored in the basins ranges from 10,000 to 25,000 gallons. It is estimated that within a radius of about 1,200 feet of these established sites more than 10,000 buildings are protected to varying degrees. It has been further estimated that, exclusive of contents, the valuation of the buildings coming under *(Continued on page 368)*

Presented before the Farm Structures and Rural Electric Divisions of the American Society of Agricultural Engineers in joint session at Chicago, December 3, 1935.

Author: Engineer, division of chemical engineering, USDA Bureau of Chemistry and Soils. Mem. ASAE.

Cotton Ginning Investigations (BAE, USDA)

IN THE considerable handling and processing which cotton undergoes between the harvesting of the seed cotton and the marketing of the ginned lint, there are many chances for adversely affecting the value of the crop. To perfect the process of ginning, in its broad sense including all the treatments in conditioning the seed cotton, removing the foreign matter, separating the fiber from the seed, and baling the lint for shipment, so as to preserve in the lint and seed the full value of the qualities that obtain in the crop as it is grown, is the objective of the cotton-ginning investigations of the U. S. Department of Agriculture. The intended beneficiaries are primarily the growers of the crop and the users of the manufactured products, but the ginning industry is benefitted as certainly and even more immediately. The ginning experiments are under the immediate supervision of Charles A. Bennett, senior mechanical engineer of the Bureau of Agricultural Engineering, and the associated cotton fiber studies are under Francis L. Gerdes of the Bureau of Agricultural Economics.

There are estimated to be more than 12,500 active cotton-ginning establishments in the United States. In the southeastern states the cleaning and extracting equipment is meager, the gin stands are principally of wooden construction, and the buildings are seldom fireproof or modern. Probably $5,000 would represent the value of a typical gin in that region. In the western states the equipment is elaborate, usually of all-metal construction housed in single-story, fireproof buildings, and frequently representing a total investment of more than $30,000. In the central states, the equipment is intermediate between that of the southeast and southwest.

Cotton-drying investigations begun in 1926, before agricultural engineering was separated from the Bureau of Public Roads, led to the invention of a process for artificially drying seed cotton which has become known as the "government process." Further studies have resulted in perfection of the present vertical-type drier upon which a public patent has been obtained, and of several driers designed by private manufacturers. Reports from commercial gins indicate that the government-designed vertical driers, and other types using the government process, handled approximately 250,000 bales of damp seed cotton from the 1934-35 crop with an attendant increase in value of from $0.70 to $2.50 per bale.

The cotton-ginning laboratory at Stoneville, Miss., was constructed in 1930, and is operated jointly by the Bureau of Agricultural Engineering and the Bureau of Agricultural Economics. It consists of (1) a three-story building containing a wide variety of drying, cleaning, conditioning, and ginning apparatus, and well-equipped shops for making experimental apparatus; (2) a three-story building housing the fiber laboratories; (3) a cotton house and an all-steel storage building for storing cotton not ginned immediately; and (4) miscellaneous features such as a sun-drier, delinting house, artesian well, incinerator, and superintendent's dwelling.

The experimental machinery includes commercial saw-and-roller gin stands, air-line and out-of-air cleaners, extractors, etc. These machines are equipped with motor-driven, variable-speed devices, by means of which a wide range in speeds may be quickly obtained.

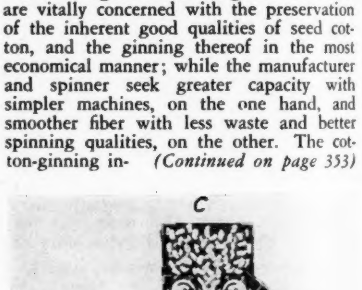
The method employed in the ginning studies is both experimental and analytical. The equipment is designed to control the major variables within narrow limits, thus enabling observations to be made of the effects of varying any particular factor. Attempt is made to first determine separately the effects produced by driers, cleaners, extractors, and cleaning feeders, by varying the speed of the gin saws, and by using different seed-roll densities. Comparisons of different mechanical devices and practices are based upon the value of the lint ginned from a given amount of seed cotton.

In a series of annually repeated tests, representative types of cleaning, extracting, and ginning machinery have been subjected to a variety of special studies. Different mechanical designs of cleaners and extractors do not appear to affect the final sample of ginned lint so much as do moisture content, foreign matter content, staple length and the rate of feeding to the gin stands. Thus far no machine has been found capable of restoring to roughly harvested seed cottons those properties that might have been retained through careful picking by hand. Nevertheless, in some districts cotton is snapped instead of picked when there is a labor shortage or need for rapid harvesting. Under such conditions there is need for facilities for cleaning and extracting the cotton at the gin and the installation of necessary equipment is of benefit to farmer and ginner alike. The laboratory tests have indicated that approximately 14 cleaning cylinders supplemented by master or unit extractors are the optimum for roughly harvested or snapped cottons, and that huller gins have advantages over plain gins fully warranting the additional cost.

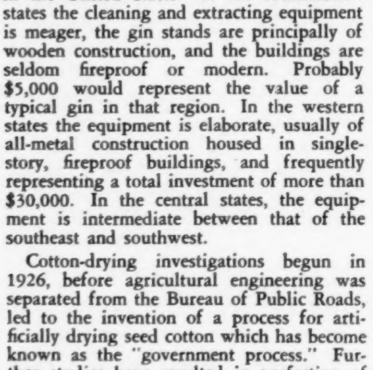
A broad range of research tests has been made to determine the relative influence of gin-saw speed and seed-roll density on the quality of ginned lint, and on the operation of the gin stands. Such have clearly shown that moderate variations in saw speed are generally insignificant in effect upon lint quality and energy requirement, but that increasing the rate of feeding seed cotton into the gin stands to produce a tight seed roll caused significant damage to the lint, and slightly increased energy consumption per bale. Evaluations by cotton technologists of the Bureau of Agricultural Economics showed net benefits as high as $4.50 per bale from ginning with a loose seed roll.

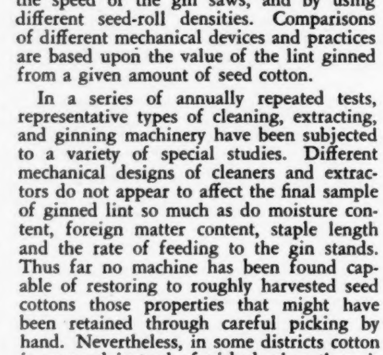
In actually separating the cotton fiber from the seed there are other processes and functions besides gin-saw speed and seed-roll density that affect the quality and cost of the lint. Conclusive data covering some of them have not yet been obtained, but many interesting studies have been carried on relating to the pitch, shape, fineness, and sharpening of the gin-saw teeth. Other studies are under way relating to the effectiveness and characteristics of the methods by which the ginned fibers are removed or doffed from the gin saws. The oldest manner of doffing is by a revolving brush. A more modern development is a high-velocity air jet which blows the lint off the saws. Much of the importance in the problems of brush speeds and nozzle pressures has now been determined, but much also remains to be done.

Both the grower and the ginner of cotton are vitally concerned with the preservation of the inherent good qualities of seed cotton, and the ginning thereof in the most economical manner; while the manufacturer and spinner seek greater capacity with simpler machines, on the one hand, and smoother fiber with less waste and better spinning qualities, on the other. The cotton-ginning in- *(Continued on page 353)*



Sectional view of an air-blast gin showing seed cotton entering feeder hopper at *C*, feeder *D*, gin front *E*, picker roller *F*, gin saws *G*, seed roll *H*, ginned lint discharge *J*, ginned seed discharge *K*, and trash droppings L. *(Courtesy The Murray Company)*





(Left) An Arkansas cotton gin in operation. The seed house for storage of ginned seed is at the extreme left, octagonal cotton house next, wagon seed hopper in the back center and cotton gin on the right. *(Courtesy Wm. J. Martin)*. (Right) Interior of a modern all-steel gin in Texas.

What Agricultural Engineers Are Doing

From the BAE, USDA

THE Bureau of Agricultural Engineering, U. S. Department of Agriculture, reports the following activities:

Wells A. Hutchins has completed the manuscripts for two bulletins on mutual irrigation companies for the cooperative division of the Farm Credit Administration. One is a technical bulletin covering the study of these companies in California and Utah, with emphasis on their credit phases and costs of operation; the other is a shorter, more popular discussion of the organization and functions of mutual companies.

* * *

A newly-developed method of irrigation from perforated, portable, slip-joint pipe is to be tried out at the Umatilla Field Station, Oregon, by the Division of Irrigation of the Bureau. One advantage of this method would be the saving of water on very porous soils by reason of the possibility of applying very light irrigations. Another advantage would be the possible decrease in the damage done by curly top, a disease of many vegetable crops. The study is planned by M. R. Lewis in cooperation with H. K. Dean, superintendent of the Umatilla Field Station, and B. F. Dana of the division of fruit and vegetable crops and diseases of the Bureau of Plant Industry.

* * *

The plow test unit under construction at the farm tillage machinery laboratory at Auburn, Alabama, was completed June 11. This unit is designed to measure the forces required to hold a plow bottom in its working position by measuring the three components of draft at the hitch point, the horizontal force at a point near the shin of the plow and the vertical forces directly over the bottom. Preliminary tests show that this unit works very satisfactorily. A series of tests will soon be gotten under way to determine how the factors of speed, depth, soil, etc., affect the forces set up in a plow bottom. A similar apparatus for testing disk units is under construction.

* * *

The influence of the character of soil tillage at the Prattville field station, Alabama, shows an accumulative effect to the fifth year. On June 10 it was noted that where excessive tillage had been employed the cotton plants were 2½ inches high, while with simple tillage, permitting an open granular soil formation, the plants were 10 to 12 inches in height and fruiting had started.

* * *

A 160x160-foot screen wire cage to be used in connection with pink bollworm cultural control experiments at Presidio, Texas, was completed in May. Thus the factor of moth migration from untreated areas will be excluded in tests conducted under the cage.

* * *

A. H. Glaves of the Toledo office spent the week of June 1 at State College, Pennsylvania, where he cooperated with A. W. Clyde in testing plow attachments, using the tillage meter developed by Mr. Clyde. A preliminary study of the data secured indicates that the use of the self-aligning disk jointer reduces the total draft of a plow approximately 12 per cent from that required when the conventional colter and jointer are used. These results check closely with previous tests.

* * *

There seems to be a need for a meter capable of measuring spray liquids under high pressure. E. M. Dieffenbach has recently submitted a schematic diagram of a meter intended for this use.

* * *

W. M. Hurst and George Stafford have completed tests at Lancaster, Pennsylvania, in mechanical harvesting of pyrethrum. Two machines were used, one an altered cotton stripper and the other constructed at Arlington Farm especially for pyrethrum. Both machines worked well in fields where the crop was upright, but in fields where the plants were lodged the need for a mechanical pick-up attachment was evident. Additional tests will be made near Reedsville, West Virginia.

Contributions Invited

All public-service agencies (federal and state), dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

From Pennsylvania

THE agricultural engineering department of the Pennsylvania State College, State College, reports the following list of active research projects at that institution, involving agricultural engineering in whole or in part:

The design of a potato harvesting machine to meet Pennsylvania requirements. (Project No. 795)

Corn and potato production employing only mechanical power. (Project No. 780)

Accessories for use with tractors in plowing stony ground. (Project No. 797)

Artificial curing of alfalfa and other forage crops. (Project No. 794)

The development of labor-saving machinery for vegetable gardening. (Project No. 728)

The mechanics of plows and other tillage tools. (Project No. 868)

The biological life of Pennsylvania trout streams and methods of stream improvement. (Project No. 880)

Refrigeration requirements for Pennsylvania Dairy Farms. (Project No. 764)

Design of electrically heated milk utensil sterilizers. (Project No. 821)

The optimum degree of fineness in grinding grains for growing and fattening swine. (Project No. 824)

Factors affecting power requirements and capacity of dairy manufacturing machinery. (Project No. 823)

Factors involved in the production and maintenance of quality in eggs. (Project No. 873)

Comparison of electric, hot-water, battery, and coal-stove brooding systems. (Project No. 859)

The biology and control of the codling moth. (Project No. 742).

From Illinois

A NEW research project on weed control was started by the department of agricultural engineering, University of Illinois, about January 1, 1936, in cooperation with other departments, the object of which is to reduce, through better control methods and by preventing further spread of noxious weeds, the loss in agricultural production caused by weeds. This work in the department of agricultural engineering is known as Project No. 305, and the immediate plan of work includes (1) a study of seed cleaning, with special emphasis on the physical characteristics of seeds and a study of the operating efficiency of different types of seed-cleaning machines, and (2) field investigations in cooperation with other departments on tillage, chemical, covering, hoeing, and burning methods of controlling weeds with special attention to field bindweed.

* * *

The department of agricultural engineering at the University of Illinois has three new Bankhead-Jones research projects approved which will add two full-time men and one half-time man to the department's research staff.

From Montana

THE agricultural engineering department at Montana State College, Bozeman, reports the following summer work:

Heavy-Fuel-Burning, Spark-Ignition Tractor Testing. This project was started this spring. The work is being done at a Fairway Farm in northwestern Montana under actual farming conditions. Similar tests have been made on gasoline and distillate-burning, spark-ignition engines and on the Diesel tractors, and it was felt that these new experiments were needed to fill the gap between the Diesel and gasoline tractor.

Water Wheels. The drought conditions throughout the West have revived interest in the use of water wheels for irrigation purposes, and the need for light and power maintain interest in small power development along our streams. A study of the use of wheels for such purposes is being made and several different designs have been tested in the laboratory.

Pumps for Irrigation. Cooperating with the irrigation department, studies have been made of various designs of homemade water-lifting devices, and the so-called Stockton or Portuges box pump has been developed to give rather satisfactory efficiency for low lifts. Several of these have been installed and tested in pumping plants.

NEWS

Conference on Upstream Engineering Called

A "CONFERENCE on Upstream Engineering" to be held in Washington, D. C., September 22 and 23, has been announced by the organizing committee, Hugh H. Bennett, chief of the Soil Conservation Service; Morris L. Cooke, Administrator of the Rural Electrification Administration; and F. A. Silcox, chief of the Forest Service. This committee was recently appointed by the President to organize the Conference for the announced purpose of coordinating engineering knowledge on the subject with a view to increasing effectiveness in saving soil and controlling floods.

In a letter from Mr. Cooke, for the Committee, the American Society of Agricultural Engineers has been asked to cooperate.

In the preliminary announcement the purpose is stated more fully as follows: "Recent flood control legislation sets the stage for comprehensive surveys looking towards a large program of development and control of water resources, and of land in relation thereto. Flood control is now viewed as involving more than control of the waters of large rivers; as involving also control of the floods of tributaries, and even of waters in the smallest streams and at the infiltration and run-off stage; prevention engineering as well as counteraction engineering. This is a comprehensive view of engineering problems in relationship which have heretofore been considered as belonging to distinct fields. It is therefore important that the engineering profession consolidate its information concerning these related problems and the pertinent techniques. The conference here announced is designed to make a beginning of such a consolidation. . . .

"All engineers, and all others interested in the use, control and conservation of water and land resources, are cordially invited to attend.

"This preliminary announcement is an invitation for comments and suggestions. Address: Upstream Engineering Committee, Room 635, Investment Building, 15th and K Sts., Washington, D. C."

The tentative program calls for papers, addresses, and discussions on the following subjects: "Basic Principles of Water Behavior," "The Influence of Vegetation on Land-Water Relationships," "Management and Use of Forest and Range Lands," "Management and Use of Agricultural Lands Including Farm Woods and Pastures," "The Comprehensive Point of View of Engineering," "Big Waters and Little Waters," "Surface and Subsurface Storage," "Control and Use of Small Streams," "Physical and Functional Relationships," and "Organization for Action."

In view of an apparent oversight, in the program planning, of the extent of agricultural engineering work in upstream engineering, it has been suggested that interested agricultural engineers, so far as possible, attend the conference and secure copies of the proceedings "with the idea of taking the results thereof into consideration in further agricultural engineering activities which involve the prevention of runoff and erosion at the source."

In its monthly news letter American Engineering Council says of the Conference:

" 'There is a wealth of experience and data as to downstream engineering and works required for navigation, power development, and flood control—levees, large dams, great reservoirs, and channel improvement on major streams; but necessary as these are for the safeguarding of those who live in areas subject to destructive floods and of property located therein, it must be remembered that downstream waters originate largely in upstream areas.'

"The foregoing is a quotation from a letter recently written by President Roosevelt to Secretary Wallace appointing a committee to handle the Upstream Engineering Conference. In the same letter, he also says: 'There are indications that a substantial body of technical information on the control of little waters is now available in the scattered records of American experience—federal, state, and professional. The urgent problem is to bring these data together into a coordinated body of engineering knowledge so that public officials and engineers may have a more definite picture of upstream engineering as an important field of public and professional activity.'

"Engineers are even more interested in another statement in that same letter, in which the President says, 'Upstream engineering will have a major part in the efforts to save the land and control floods, and for that reason it offers a broad field of opportunity for the engineering profession. I am, therefore, in hearty accord with—an open conference'—and 'I am appointing Messrs. Hugh H. Bennett, chief of the Soil Conservation Service of the Department of Agriculture, Morris L. Cooke, administrator of the Rural Electrification Administration, and F. A. Silcox, chief of the Forest Service of the Department of Agriculture'—a committee of three to organize and promote the conference.

"The Upstream Engineering Conference is scheduled to consolidate available public and private engineering information on these several related problems and pertinent techniques. It seeks to emphasize prevention engineering with reference to the development and control of water resources and land conservation and use. Counteraction engineering on downstream work may be the secondary consideration, but the engineers who harness the waters of large streams also know about precipitation, runoff, and little waters; and out of their records of observation and experience must come the practical knowledge for immediate use.

"In other words, engineering is called upstream with its knowledge of precipitation, infiltration, runoff data, and stream gauging to practice prevention engineering at the source. Instead of struggling against the usual indifference, engineers are recognized as authorities and invited to take a leading part in the conservation and utilization of 'rural aristocracy.' For the first time, the engineering profession is offered an adequate forum and official recognition for its technical competence, constructive imagination and appreciation of social and economic necessities. At least, one manifestation of the awakening of public consciousness of the sound value of engineering and the engineer citizen's contribution to society is back of the invitations about to be extended to the Upstream Engineering Conference.

"According to current definition, upstream engineering is largely civil, chemical, and agricultural on the site, but mechanical, electrical and many other branches are just as essential behind the lines. It has truly great potential possibilities for all branches of engineering and allied economic activities. It merits investigation and serious consideration by all engineers interested in the public welfare and the maintenance of a proper economic balance in these United States."

Washington News-Letter

from American Engineering Council

THE Bureau of Labor Statistics is completing the first all-inclusive survey of the engineering profession. It was made under the supervision of the Committee on the Engineering and Allied Technical Professions of the American Engineering Council, to provide more accurate information regarding engineers and engineering in the United States. The June issue of the Monthly Labor Review, published by the Bureau of Labor Statistics of the United States Department of Labor, carries the first official release under the title, "Education and Training." It concludes that a first degree in engineering is now almost a prerequisite in order to attain professional status and a position, and that "by and large the respective curricula of engineering colleges meet the needs of the profession." Other interesting results of the survey will be reported serially in subsequent issues of the Monthly Labor Review and finally published for distribution through the Government Printing Office.

The procurement division of the treasury at Seventh and D Streets, S.W., Washington, announces a permanent display of architectural building materials by producers' associations open to the public during business hours on the fifth floor of the new building at that address. The exhibit occupies eleven rooms and includes a wide variety of practically all natural and manufactured building materials produced in the United States. The purpose is to provide a technical reference library of materials for the convenience of engineers and architects in government and private practice, contractors, manufacturers, and students of technical universities to which they may turn for exact information as to form, color, textures, and other properties affecting application or use in the design and construction of both public and private buildings.

The Public Works Administration reports that nearly 60 per cent of its funds have been used to pay materials manufacturers, and that the employment provided in industry far exceeds that of direct em-

ployment on the sites. They estimate that amount to be $1,331,500,000. Of this amount, 70 per cent is claimed to have been used to meet payrolls in mines, mills, and factories.

In this announcement that there would be no change in the established basic policies of PWA with respect to the allotment of $300,000,000 made available by the last Congress, Secretary Ickes has said, "Further effort will be made to encourage applicants to provide applicant contributions from sources other than the sale of securities to the Government of the United States. Allotments will first be made on those projects for which applications for grants only are pending. Any request for a change in an application from a loan to a grant only should be accepted by the state offices and immediately forwarded to Washington in accordance with the existing procedure."

A recent announcement regarding the selection of tenants for the new Techwood Homes Slum Clearance Project in Atlanta, Georgia, states that such tenants must be selected from among families of low income now forced to reside under subnormal or slum housing conditions. All others will be barred from living in these new low-cost homes. An income range of such families is now set at from $700 to $1,800, varying with the size of the families. Rentals will range from $16.40 for three-room apartments to $31.30 for the highest priced six-room group house. Utility service will be furnished at cost, but all families must use electric refrigeration and cooking stove, electric lights, steam heat, and bathroom facilities. It is reported that these regulations with slight local changes are to apply to each one of the fifty housing projects already under construction in this country and all of its insular possessions. It is interesting to note, however, that preference will be given to low-income families who are self-sustaining and to those families whose head is a citizen of the United States.

Rural Electrification Administration loans are being accepted at a surprising rapid rate by cooperatives and a few utilities. The largest loan announcement to date is for the McLeod and Douglas County Cooperative Power Associations in Minnesota. It is to finance the construction of almost 600 miles of lines to serve approximately 2,000 farms and rural communities. The REA is now active in 35 states and has loans and allocations approximating $15,000,000 for the construction of more than 15,000 miles of lines to serve over 50,000 new customers in rural areas.

REA launched a new phase of its program on June 18, 1936, when it began making loans to cooperatives to be reloaned to customers, to pay for wiring farmsteads and the installation of equipment and appliances. Such loans may now be made by cooperatives up to 80 per cent of the cost of wiring and installation and be repaid over periods up to five years in equal semi-annual installments with 3 per cent interest on the unpaid balance.

In announcing the availability of reloan privileges, Administrator Morris L. Cooke has emphasized the requirement that all plans and specifications must call for first-class materials and workmanship and should make adequate provision for future expansion to permit the addition of new electrical appliances. Mr. Cooke is also reported to have discussed this new program with representatives of the Brotherhood of Electrical Workers and the National Electrical Contractors Association.

ASAE Meetings Calendar

October 12 to 14, 1936 (tentative dates)—North Atlantic Section—(Location to be selected.)

October 23 and 24 (or 30 and 31), 1936 (tentative)—Pacific Coast Section, at Moscow, Ida., and Pullman, Wash.

November 30 and December 1 to 3—Power and Machinery Division, Rural Electric Division, Farm Structures Division, and Soil and Water Conservation Division (individual and joint programs)—Stevens Hotel, Chicago.

February 3 to 5, 1937—Southern Section (in conjunction with annual convention of the Association of Southern Agricultural Workers)—Nashville, Tenn.

June 21 to 24, 1937 (tentative dates)—Annual meeting of the Society—University of Illinois, Urbana-Champaign.

Farm Wiring Booklet Distribution

EARLY this month a copy of the paper, entitled "The Farm Wiring Problem," by H. G. Knoderer, will be mailed to all readers of AGRICULTURAL ENGINEERING, including nonmembers as well as members of ASAE. This paper was presented before the Rural Electric Division at the recent annual meeting of the American Society of Agricultural Engineers at Estes Park, Colorado. It was printed in separate form in advance of the meeting, and its distribution is made possible through the courtesy of the author. Failure of readers to receive a copy of this paper should be reported to the Secretary of ASAE.

Cotton Ginning Investigations

(Continued from page 350)

vestigations are designed to aid in bringing about these improvements.

Up to this time, capacity of the ginning machinery has been restricted somewhat whenever quality of the ginned lint was of prime importance. One of the major problems now confronting agricultural engineers is the development of ginning machinery that will have capacity equal to previous tight seed-roll operations and at the same time retain the quality benefits heretofore obtained only by a loose seed roll. Another problem is to render the units and combinations of ginning machines simpler and more economical in consumption of energy, so that ginning costs may be reduced.

Energy consumption and power requirements are being recorded and analyzed for the different machinery set-ups, and tests of cotton piping, fans, and other handling equipment are being subjected to close scrutiny. It has been estimated that gin fans alone are wasting some 40,000 horsepower because of inefficient operation.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the July issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

J. J. Bass, Jr., assistant agricultural engineer, agricultural engineering extension division, Virginia Polytechnic Institute, Blacksburg, Va. (Mail) Box 573.

Waldo E. Bell, project engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 30 N. Potomac Ave.

W. M. Bruce, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) High Point, N. C.

J. Lawrence Calhoun, engineering aide, Tennessee Valley Authority, Knoxville, Tenn. (Mail) Room 345, Y.M.C.A.

Carl F. DuPre, engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 624 S. 8th St., Shelbyville, Ky.

Julian M. Fore, agricultural engineering department, Purdue University, LaFayette, Ind. (Mail) 427 State St., West LaFayette.

K. B. Huff, extension agricultural engineer, University of Missouri. (Mail) Agricultural Engineering Department, Columbia, Mo.

Frank B. Lanham, research engineer, agricultural engineering department, University of Georgia, Athens, Ga.

Max Meisels, junior irrigation engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) 1011 E. Grand Ave., Albuquerque, N. Mex.

Maurice E. O'Brien, manager of sales, Inland Steel Co., 38 So. Dearborn St., Chicago, Ill.

Otis M. Page, senior agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Chisco Hotel, Memphis, Tenn.

Nicholas V. Poliacov, The All-Union Research Institute for Hydrotechnics and Reclamation, Moscow, 8, U.S.S.R. (Mail) Nijniadoroga 19.

D. W. Rice, agricultural service division, West Penn Power Company. (Mail) 316 Frederick Ave., Sewickley, Pa.

Jefferson B. Rodgers, field engineer, Idaho Committee on the Relation of Electricity to Agriculture, Room 302, Engineering Building, University of Idaho, Moscow, Idaho.

Charles T. Savage, International Harvester Co. (Mail) Whaleyville, Va.

W. D. Scoates, associate professor of agricultural engineering, John Tarleton College. (Mail) College Station, Texas.

Dale A. Shelton, John Deere Plow Company, Spokane, Wash. (Mail) South 320 Washington St.

Russell C. Shipman, agricultural engineering department, Purdue University, LaFayette, Ind. (Mail) 328 Lawn Ave.

Joseph W. Slater, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 707 East Van Trees St., Washington, Indiana.

N. J. Taylor, field work, Humble Oil & Refining Co., Box Z, Hobbs, N. Mex.

Eugene D. Warner, extension architect, Kansas State College, Manhattan, Kans.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

MODERNIZING FARMHOUSES, *W. Ashby* and *W. H. Nash*. U. S. Dept. Agr., Farmers' Bul. 1749 (1935), pp. II + 62, figs. 66. This bulletin presents examples of modernizing that have been accomplished, alternate plans for some of these situations, and plans for some typical conditions not represented by the other examples.

SOME ASPECTS OF RESEARCH IN THE SOIL CONSERVATION SERVICE, *W. C. Lowdermilk*. Soil Conserv. [U. S.], 1 (1935), no. 5, pp. 1-7, figs. 7. A brief outline is given of the essential features of the research program of the Soil Conservation Service.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE ARKANSAS STATION, *D. G. Carter, J. B. Woods, R. M. Smith, R. P. Bartholomew,* and *L. C. Kapp*. Arkansas Sta. Bul. 323 (1935), pp. 7, 8. The progress results are presented of investigations on durability of posts and methods and preservative treatment, influence of poultry housing factors on egg production, farm buildings for Arkansas, and soil erosion control.

PROGRESS IN THE STUDY OF THE MECHANICAL HARVESTING OF COTTON, *H. P. Smith, D. T. Killough, D. L. Jones,* and *M. H. Byrom*. Texas Sta. Bul. 511 (1935), pp. 35, figs. 13. This bulletin reports the results obtained in the study of the mechanical harvesting of cotton and describes improvements made on the Texas Station cotton harvester during the period 1932-34 to increase its efficiency. A complete description is also given of the construction of an experimental roll-type sled harvester, of a bur extractor, and of a cylinder cleaner.

Tests made in 1932 with the roll-type stripper sled to determine what effect the angle of the rolls, the size of the rolls, and the speed at which they revolve would have on the efficiency of stripping rolls constructed of wood and steel indicated that (1) stripping rolls made from steel or wood having a slightly roughened surface gave a high efficiency when used to harvest cotton, (2) stripping rolls 2-3/16 inch in diameter were more efficient than rolls 3 inches in diameter, (3) the most efficient angle for operating stripping rolls 56 inches in length was between 25 and 30 degrees with the ground, and (4) a study of the relation of roll travel to tractor travel showed that a higher percentage of the cotton was harvested when the roll travel was faster than the tractor travel.

When stripping rolls made of wood, steel, and rubber were used in the Texas Station harvester at three roll speeds and set at an angle of approximately 28 degrees, the highest percentage of the cotton was harvested with the highest roll speed. Similar results were secured when rubber rolls and knurled surfaced steel rolls were compared at different speeds. The rubber rolls operated at high roll speed harvested 96.8 per cent with Ducona cotton and 95.5 per cent with Lone Star cotton, while the knurled surfaced steel rolls harvested 96.2 per cent with Ducona and 97.0 per cent with Lone Star.

Rubber stripping rolls harvested a higher percentage of cotton than wood or steel stripping rolls. There was no significant difference in the efficiency of rubber rolls and knurled surfaced steel rolls.

Comparisons of the effect of roll speeds indicate that a higher percentage of the cotton is harvested with a high roll speed. When the effects of tractor speeds were compared, the average percentage of the cotton harvested was 96.0, 95.5, and 94.7 per cent for low, second, and high tractor gear speeds, respectively. The feet travel of the roll surface per foot of tractor travel was 1.02 feet for low, 0.68 foot for second, and 0.50 foot for high tractor gear speeds.

The relation of roll travel to tractor travel was found to be an influencing factor on the efficiency of stripping rolls, since there was an average increase of approximately 23 per cent in roll travel per foot of tractor travel of medium roll speed over low roll speed, an increase of approximately 13 per cent of high over medium roll speed, and an increase of approximately 33 per cent of high over low roll speed. In 9 of 15 comparisons the low roll speed harvested a higher percentage of the cotton than the medium roll speed, in 12 of 15 comparisons the high roll speed was more efficient than the medium roll speed, and in 14 of 15 comparisons the high roll speed was more efficient than the low roll speed.

Mechanically harvested cotton cleaned on the Texas station bur extractor and on the Texas Station cylinder cleaner in 1934 removed burs, unopen green bolls, dirt, and trash, including leaves and stems, amounting to approximately 50 per cent of the weight of the harvested cotton from the Ducona variety and 51 per cent from the Lone Star variety.

Ducona cotton cleaned on the Texas station bur extractor and on the Texas station cylinder cleaner in 1934 classed two grades higher than Ducona cotton extracted and cleaned the same year with available commercial bur extracting and cleaning equipment.

The efficiency of the Texas station cotton harvester was greatly influenced by the varietal characteristics of the different varieties harvested. In tests with a number of varieties of cotton in 1932, 1933, and 1934, the highest efficiency, 96.6 to 99.0 per cent, was obtained in harvesting varieties in which the plants had short fruiting branches, short vegetative branches, and storm-resistant bolls.

An average of 16.5 per cent of the green leaves was removed from the plants in full foliage at the time of harvesting the cotton in September. The leaves in the cotton contained an average of 71.6 per cent moisture. There was 60.8 per cent moisture in the unopen mature green bolls and 71.7 per cent moisture in the unopen immature green bolls that were collected with the green leaves in harvesting the cotton.

ENGINEERING FIELD TABLES. U. S. Dept. Agr., Forest Serv., 1935, 2, ed., pp. IV + 118, figs. 18. This is the second edition of this handbook. It contains sections on curves, surveying, meridian, trigonometric functions, earthwork, road surfacing, pipe culverts, concrete, timber, and miscellaneous.

RELATIVE GROWTH AND DRY WEIGHT PRODUCTION OF PLANT TISSUE UNDER MAZDA, NEON, SODIUM, AND MERCURY VAPOR LAMPS, *J. M. Arthur* and *W. D. Stewart*. Contrib. Boyce Thompson Inst., 7 (1935), No. 2, pp. 119-130, figs. 3. The growth and dry weight production of buckwheat plants were studied under neon, mercury vapor, and sodium vapor lamps in comparison with a 500-watt Mazda lamp, and the Weston photronic cell was used to determine the points of equal light intensity.

Assuming the average dry weight per plant produced under the Mazda lamp as 1, the value for the neon lamp was 1.1, for the sodium vapor 0.9, and for the mercury vapor 0.66. Calculating the dry weights which might have been produced if equal amounts of energy in the visible region had been used, these values would be for the Mazda 1, for the sodium vapor 1.41, for the neon 1.2, and for the mercury vapor 0.62.

A consideration of the chlorophyll spectrum showed no relation between the emission bands of these lamps, the absorption bands of the chlorophyll pigments, and the efficiency of the various lamps in producing dry weight of plant tissue. The sodium lamp proved most efficient, with the main output of energy at wave length 588 and 589 millimicrons, where chlorophyll absorption is near the minimum. The neon lamp was second in efficiency with the main output band near the maximum of chlorophyll absorption in the red-orange region. The mercury vapor lamp was least efficient, yet had much of the energy output in the blue-violet region where chlorophyll absorption is at the maximum. The sodium lamp had an efficiency of 45 lumens per watt and the remarkably low power loss in the auxiliary transformer unit of only 25 watts, as compared with a current consumption of 200 watts in the arc itself. It therefore offers considerable promise as a cheaper and more efficient light source for growing plants. All gaseous discharge lamps produced greener leaves and a lower ratio of stems to leaves than did the Mazda lamp.

DEGREE DAYS FOR COOLING, *A. D. Marston*. Bul. Amer. Met. Soc., 16 (1935), No. 10, pp. 242-244. It is stated that "'degree days' are fairly well established as a basis for estimating heating costs and are now to be included in monthly meteorological summaries. With the growing use of air conditioning, there rises a question concerning the possibility of using some similar guide to cooling costs. Unfortunately there are not enough data available to justify the final selection of such a guide. Those who have such information available should cooperate to the end that a satisfactory basis may be developed."

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FLUORESCENCE IN CITRUS FRUITS INDUCED BY ULTRAVIOLET RAYS [trans. title], *E. Bottini.* R. Staz. Chim. Agr. Torino Ann., 12 (1932-34), pt. A, pp. 253-270, pls. 7. The results here reported indicate that the cause of the diverse fluorescences exhibited by the various citrus fruits under Wood's light resides in the particular substances present in the essential oils of these fruits. These substances vary from species to species and give rise to fluorescences of different colors. The chemical base of these differences are discussed in detail for lemon, orange, mandarin, citron, bergamot, and grapefruit, and the phenomena are illustrated in color.

FARM DRAINAGE PRACTICE, *H. B. Roe* and *J. H. Neal.* Minn. Univ. Agr. Ext. Spec. Bul. 149, rev. (1935), pp. 24, figs. 25. Technical information is given on the subject.

A NEW TYPE OF INSULATED GREENHOUSE HEATED AND LIGHTED BY MAZDA LAMPS, *J. M. Arthur* and *L. C. Porter.* Contrib. Boyce Thompson Inst., 7 (1935), No. 2, pp. 131-146, figs. 5. This refrigerator-type greenhouse with a 6-foot growing bench was designed and built to use sunlight and Mazda lamps as sole sources of both light and heat, the lamps being operated by a thermostat set to maintain a temperature above 60 degrees (Fahrenheit). It was constructed of double sheet-metal walls soldered at the joints and filled in between the metal faces with dry sawdust, making it almost airtight so that additional concentrations of carbon dioxide could be maintained economically by the use of pieces of solid carbon dioxide.

The average daily amount of light supplied as a supplement to daylight was 4 hours and except on cloudy days it was all supplied at night. This produced a rate of growth and flowering during winter, when the light intensity is lowest, which is believed equivalent to that in an ordinary greenhouse in March and April.

ARTIFICIAL LIGHT AS AN AID TO TOMATO GRADING, *F. C. Gaylord* and *J. H. MacGillivray.* Amer. Soc. Hort. Sci. Proc., 31 (1934), pp. 532-535. Observations by the Indiana Experiment Station on the effect of different kinds of light on the accuracy of tomato grading by commercial workers showed much smaller differences than were anticipated, probably because the workers established more or less unconsciously color standards for each light environment. There were, however, a greater number of mistakes under frosted lamps than with any other types, and the workers themselves reported greater fatigue in the frosted lamp light. On the other hand workers were generally positive in their preference for daylight lamps. The results led the authors to recommend correctly selected lamps as a help in the grading of agricultural products involving a consideration of color.

STORAGE OF YELLOW NEWTOWN APPLES IN CHAMBERS SUPPLIED WITH ARTIFICIAL ATMOSPHERES, *F. W. Allen* and *L. R. McKinnon.* Amer. Soc. Hort. Sci. Proc., 31 (1934), pp. 146-152. Observations at the California Experiment Station at Davis on fruits from a single tree stored at 36 and 42 degrees (Fahrenheit) in large glass bottles in which the percentages of carbon dioxide were increased to 5, 10, and 15 showed after 3 months of storage that the gas-stored were still too firm for best eating, while those in ordinary air at both temperatures were fully ripe. The flesh of the 10 and 15 per cent carbon dioxide apples was slightly woody, but no discoloration or off-flavor could be detected. About 2 months later the air-stored apples were practically worthless, whereas the gas-stored fruits showed no injury and the 5 and 10 per cent lots were crisp and firm. As late as May 12 the fruits in 10 per cent carbon dioxide were still moderately crisp and juicy. Analyses of fruit of the March and May samplings showed no marked or constant differences in sugar, but the percentage of malic acid was lower in the normal-air lots.

FACTORS INFLUENCING THE REFRIGERATION OF PACKAGES OF PEACHES, *J. W. Lloyd* and *S. W. Decker.* Illinois Sta. Bul. 418 (1935), pp. 437-464, figs. 11. Following the same procedure as outlined for an earlier study with apples, the authors found that Elberta peaches packed in lined tub bushel baskets held at a temperature of 34 degrees (Fahrenheit) did not develop as great temperature differences between outside and center rows of fruit as did Grimes Golden apples held under comparable conditions. The peaches cooled more rapidly than did the apples during the early stages, but after 6 to 8 hours in the chamber the apples cooled faster. The air temperature between the outer and second rows was about midway between the fruit temperature of the two rows, whereas between the third and fourth rows the air temperature was below that of the fruit in the third row. The rate at which fruit within a basket cooled was largely dependent upon the difference between the temperature of the air surrounding the fruit and that of the fruit itself. The size of peaches did not materially affect the rate of cooling. The use of ventilated liners in well-constructed tub baskets did not greatly interfere with the cooling of the fruit. Peaches packed in lined tub bushel baskets and in ventilated corrugated bushel boxes cooled at approximately the same rate. Fruit in lined half-bushel containers cooled more rapidly than in lined tub bushel baskets. Fruit in an unlined ventilated bushel basket cooled to 50 degrees in half the time required for lined tub bushel baskets. The use of oiled wraps retarded materially the cooling of peaches.

THE COOL STORAGE OF PLUMS, *G. B. Tindale, S. A. Trout,* and *F. H. Heulin.* Jour. Dept. Agr. Victoria, 33 (1935), No. 11, pp. 552-554. Stimulated by the generally poor condition on arrival of overseas shipments of Victoria-grown plums, fruits of several varieties picked in the immature and approaching maturity stages were promptly stored in the Government Cool Stores at Melbourne at 31 and 34 degrees (Fahrenheit). The longest storage life was observed at 31 degrees; in fact at 34 degrees storage life was approximately 25 per cent shorter. The first indication of the breaking down of stored fruit was a general mealiness associated with loss of flavor. Plums picked in the immature stage, although taking on color, never did attain eating quality. As a class the *Prunus domestica* varieties kept longer than the Japanese, the longest keeper of the 10 varieties tested being Golden Drop, which held for 8 to 9 weeks. Increases in the carbon dioxide of the storage atmosphere decreased the life of the plums.

CLIMATOLOGICAL DATA FOR AIR CONDITIONING. Bul. Amer. Met. Soc., 16 (1935), No. 10, pp. 241, 242. Reference is made to the marked increase in the use of air conditioning equipment in the last few years, and to the publication by the USDA Weather Bureau of tabulations of certain values especially needed for air conditioning engineering and operation.

"The most generally required values are the so-called 'degree days.' The number of degree days for heating or winter air conditioning for a month is determined by totaling the daily deficiencies in the mean temperature (maximum plus minimum divided by two) relative to 65 degrees (Fahrenheit). The totals should be computed for all those months in which some or all the days have mean temperatures below 65 degrees. The base value of 65 degrees has been determined empirically and is generally agreed on by engineers."

THE STRUCTURE OF SOILS AS AFFECTING SOIL EROSION, *J. F. Lutz.* Amer. Soil Survey Assoc. Bul. 15 (1934), pp. 98-100, figs. 2. A much eroded North Carolina soil, the Iredell sandy clay loam, was compared with Davidson clay, a soil not especially subject to erosion. It is stated that "the greater percolation of water through the Davidson soil as compared with the Iredell is due to several factors: First, the Davidson is more highly aggregated; second, a high percentage of the aggregates in the Davidson are larger than those in the Iredell; and, third, there is a difference in the type of aggregates. Because more water percolates through the Davidson there is less runoff, and, consequently, less erosion. Also, the larger size of the effective particles in the Davidson makes them less subject to dispersion and erosion."

SOME PLANT AND SOIL-MOISTURE RELATIONS, *F. J. Veihmeyer* and *A. H. Hendrickson.* Amer. Soil Survey Assoc. Bul. 15 (1934), pp. 76-80, figs. 2. An investigation reported from the University of California has yielded data showing the constancy of the permanent wilting percentage under widely different evaporating conditions.

"The results mentioned here indicate that the permanent wilting percentage represents a definite soil-moisture condition that is remarkably constant for any given soil under any evaporating condition likely to be obtained with plants growing in the field. Therefore the importance of surface forces in the soil in causing the wilting of plants is suggested." It is further pointed out that "the exhaustion of readily available moisture is generally indicated by drooping or curling of the leaves, but in some plants this effect is not obvious. In such cases it is necessary to look for other indications of lack of readily available water such as change of color of leaves, or a marked decrease in the rate of growth of the plant or fruit. In some cases, however, the reduction of the moisture to the permanent wilting percentage for short periods does not result in any apparent changes in the plant. Therefore, it is essential to know how long the plants lack readily available moisture. Such terms as 'lightly irrigated', 'heavily irrigated', 'kept at optimum', 'high', 'medium', and 'low' moisture plats are meaningless because they do not give the essential information necessary to interpret the soil-moisture conditions."

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Preparation and Presentation of Extension Subject Matter

(Continued from page 332)

which an audience should be expected to read a well-lighted chart having clear-cut letters one inch high and strokes one-eighth inch wide.

The use of a blackboard is advantageous, not only to illustrate construction details or to emphasize significant figures, but also to hold or regain the interest of the audience. It is one way to break the monotony of a monologue.

The extension agricultural engineer has many opportunities to effectively use models to show how an object is constructed, how it works, or to illustrate distinct differences in the performance of devices or materials.

We have found septic tank models, built to one-fourth scale, a convenient and clear way of illustrating methods of construction.

An oversized model of a breaker-box and distributor head, made to such a scale that the breaker points are represented by ½-inch cap screws, is useful in illustrating the operation and adjustment of an ignition system, because a fair sized group can see what you are talking about.

Small models may be more effective to show contrasts in performance than are the actual machines. For example, we wished to show orchardists who used "tank-mix" oils that the type and speed of agitator blades in their spray tanks could cause the difference between success and failure in obtaining a uniform mixture of oil and water. The Divisions of Agricultural Engineering and Entomology at the University of California had worked out the characteristics of various agitators at different speeds and had recommended that the blades commonly used should be run at speeds much higher than average, or that a new but simple design of blade be used, running at normal speeds. We tried to show this in the field by running the grower's machine which gave inadequate agitation, as compared with our own spray machine, which was properly equipped. This required our taking about a large piece of equipment on a motor truck, and furthermore it was not very effective teaching because the audience could not easily see the difference. Finally we made models of agitators to one-sixth scale, mounted in glass tanks. Two sets were run at the same time with dyed oil placed in the water. The contrast in agitation was distinctly visible to the audience. These models which could be carried on the back seat of an automobile told the story much better than two full-sized spray machines.

The principle of showing contrasts, as illustrated in the spray tank agitation models, is often a good method to follow in demonstrations. In our work with our extension specialist in citriculture on shallow-tillage methods, where we show the use of depth gauges on disk harrows, we first operate the harrow with the gauges on, show the work the implement does and measure the draft with a traction dynamometer; then we remove the gauges and repeat the performance. The farmers compare the work and the draft of the harrow.

Contrast is an excellent way to demonstrate good lighting. A room is poorly lighted; a switch is thrown and the room is well lighted. The story is effectively told by the quick constrast between bad and good.

It is important that the demonstration equipment works as it is supposed to; a failure is embarrassing to the demonstrator and may raise doubts in the minds of some. Furthermore, it is important that the demonstration be made with dexterity. The extension man should be able to do in a workmanlike manner the operation he is demonstrating. He is viewed as an "expert" and must handle the various details with confidence in himself gained by practice, if he is to have the confidence of the public. This applies not only to the manual operations but also to giving answers or advice on specific situations. If he suggests that a V-belt drive be used on a machine, then he should be prepared to state the number and size of belts and pulleys for the jobs and where they may be obtained. If his lighting demonstration makes it obvious that the farm center hall should have its lighting improved, then he should be ready to suggest the number, size, types, and locations of suitable lighting units. He cannot assign the problem as a class exercise for the next period.

No matter how well subject matter has been prepared and presented, as the number of presentations increases the extension man will make changes to improve clarity, emphasize some points which field experience shows to be of major importance, and debate others which prove to be of minor use.

This paper may be summarized in three sentences:

1 Select subject matter which is right and important
2 Have more subject matter than will be presented
3 Present the subject matter so that it will be heard, seen and understood.

Agricultural Engineering Digest

(Continued from page 358)

FLOUR STORAGE, *C. H. Briggs*. Northwest. Miller, 184 (1935), No. 2, Sect. 2, pp. 17, 48. It is pointed out that if wheat contains insects or insect eggs they will be destroyed during the milling process. Even the eggs of insects are of larger dimensions than can pass the meshes of the silks used in bolting flour. When contamination takes place after milling, it is the result of the hatching out of insect eggs deposited in or on the flour sacks. More than 90 species of insects and spiders have been noted in flour and other cereal products, a list of which is included.

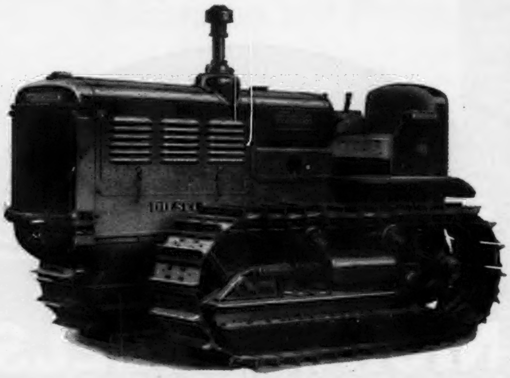
AMERICAN LUBRICATING GREASES, *J. I. Clower*. Va. Engin. Expt. Sta. Bul. 35 (1935), pp. 80, figs. 25). The purpose of this bulletin is to aid buyers and users in making a more understanding selection of greases for their needs. The point of view of the user has been emphasized throughout rather than that of the manufacturer. Information concerning the composition, manufacture, uses, and testing is given in brief, nontechnical wording. Sections are included on manufacture of greases; tests and their significance, including physical, mechanical, and chemical tests; grease vs. oil lubrication; methods of application; and specifications.

THE USE OF TILLIAGE MACHINERY IN SOIL-DRIFTING AREAS, *E. A. Hardy*. Sci. Agr., 16 (1936), No. 5, pp. 281-284, figs. 2. General information is given on the subject, emphasis being placed upon tillage practices which will produce a lumpy or cloddy condition of the soil which will resist wind action.

Books Received

PROCEEDINGS OF THE SECOND DEARBORN CONFERENCE OF AGRICULTURE, INDUSTRY, AND SCIENCE, edited and published jointly by the Farm Chemurgic Council (Dearborn, Mich.) and The Chemical Foundation, Inc. Paper bound xii and 409 pages, 7x10 inches, illustrated, fifty cents postpaid.

All addresses, papers, and discussion presented at the Second Dearborn Conference of Agriculture, Industry and Science held at Dearborn, Michigan, May 12, 13, and 14, 1936, are printed in full and in the general order of presentation. Separate chapters cover the Council Luncheon, Opening General Session, Symposium on New Things, Power Alcohol, Starch and Sugars, Plastics, Cellulose, Farm Chemurgic Banquet, Soy Bean, Insecticides and Fertilizers, Closing General Session, and Business Session. Additional information is furnished in an Introduction and an Appendix. Illustrations accompanying the papers are supplemented by pictures of a few of the personalities and exhibits of the Conference.



Water Supplies on Farms for Fire Department Use

(Continued from page 349)

this protection is in excess of $17,000,000. The average cost of the sites constructed, exclusive of materials, was approximately $225 each. Aside from providing useful work for unemployed men, this project has already proved of considerable value from the fire protection standpoint. From records available it is estimated that a total of $140,000 worth of property has been saved from destruction by fire through the use of the "water holes" constructed under this project.

Through the efforts of I. D. Goss, chairman of the Agricultural Committee of the National Fire Waste Council, and others, plans are being formulated by telephone companies, insurance groups, fire apparatus manufacturers, and other interested organizations for a three-point project, nation-wide in scope, which may become an important factor in reducing farm fire losses. This project contemplates a fire insurance rate credit to the farmer, provided there is (a) a telephone on the farm by means of which a fire alarm can be sent to the central operator; (b) a rural fire department in the community, organized and equipped according to the recommendations of the National Fire Protection Association, and (c) an adequate water supply on the farm for fire department use.

Regardless of any insurance credit that may result, this project has much merit because it would provide the farmer with fire protection comparable to a great extent to that enjoyed by the urban dweller. And that, after all, is the ideal we should attempt to attain.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

GRADUATE ASSISTANTS (3) wanted to work toward a master's degree in agricultural engineering and assist one-third to one-half time with classes in elementary mathematics, surveying and agricultural machinery; $400 to $600 in 18 semi-monthly payments, September 15 to June 15. Send recent photograph, personal and scholastic record and references. PO-114

POSITIONS WANTED

CIVIL ENGINEER, with two years agricultural engineering experience in soil conservation work, including SCS camp layout, design of small earth dams, terraces and outlets; layout of dimension ditches; drafting, blueprinting, filing, time study, general estimating; camp engineer work, including layout of field work for camp crews, general supervision of field foremen, design of erosion control structures, and preparation of reports. Desires position in construction work or with machinery manufacturer in maintenance, demonstration, or research. Looking for permanent connection with opportunity for advancement. Location immaterial. Age 27. PW-272

AGRICULTURAL ENGINEER, farm reared, with B. Sc. in agricultural education from Montana State College and M. C. from Iowa State College, major in vocational education and minor in agricultural engineering. Graduate work in agricultural engineering at Iowa State College, practically equivalent to B. Sc. degree. Eleven years of teaching experience, five years in high school vocational agriculture and five years in farm mechanics in the agricultural engineering department at Iowa State College. Two and one-half years experience in soil conservation work in ECW and the Soil Conservation Service. Also some sales experience. Desires teaching, extension service or related work in agricultural engineering. Especially interested in farm machinery and soil conservation work. Age 38. Married. PW-273